

ATED: AMD'S INSANE THREADRIPPER 3990X 64-CORE PHWOAR!

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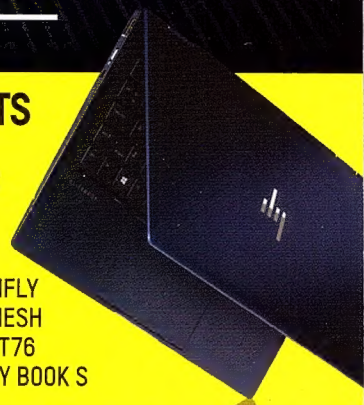


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16x
VPN

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- IPv6 & IPv4
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2x
VPN

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- 2 years back to base warranty



i-LAN Technology Pty Ltd trading as DrayTek Aust & NZ

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Star Linking

Across the internet.



As I write, SpaceX has just successfully launched its fourth Starlink mission, deploying another 60 global internet satellites for a total of 240 so far. This followed approval by the Australian

Communications and Media Authority (ACMA) at the beginning of the year for the company to operate specific frequencies in Australia, and is the first step for full entry into the Australian broadband market.

If all goes to plan, Starlink will be selling internet services to the US market later this year, and Australia (and the rest of the world) in 2021. Performance is claimed to be in the order of (up to) 1Gbps and 10-20ms latency. That is roughly 20x what a typical NBN user experiences, and quick enough for gamers to no longer care what country a server is in. And, for a total deployment cost of around \$10 billion. To service the entire globe. A quarter of what the NBN cost...

We don't know yet what model the selling part will take. Elon Musk has said it's likely Starlink will be spun off as a separate business to SpaceX once things are operational. It's likely you will buy your Starlink internet from a MVNO-type of reseller. It's way to soon to speculate about pricing, though there will certainly be many tiers plus

enterprise and consumer packages.

Inherently, Starlink works equally well – and should cost just as much – whether you're in a city CBD or at the South Pole, or on a boat in the middle of the Pacific. Or an outback cattle station. So for Australian rural and remote areas this will be a game changer.

Foxtel is chucking a stink about it all, claiming possible signal interference with its own single satellite. But we all know Rupert is simply trying to deny Australians access to the service to protect what's left of Foxtel, just like he (allegedly) did to cripple the NBN.

As with everything Elon Musk does, Starlink is astonishing in its audacious scope – and equally stunning in its pace of deployment. It's frankly incredible to watch it all take place. SpaceX is not only able to launch a Starlink-carrying rocket every two weeks for at least the next two years – but it's also building 60 satellites every fortnight, too. And that's on top of customer launches, where it has taken almost all of the commercial launch market to itself.

Exciting times! Let's just hope it's not neutered too much by a protectionist government...

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EDITOR
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"If all goes to plan, Starlink will be selling internet services to the US market later this year, and Australia in 2021."

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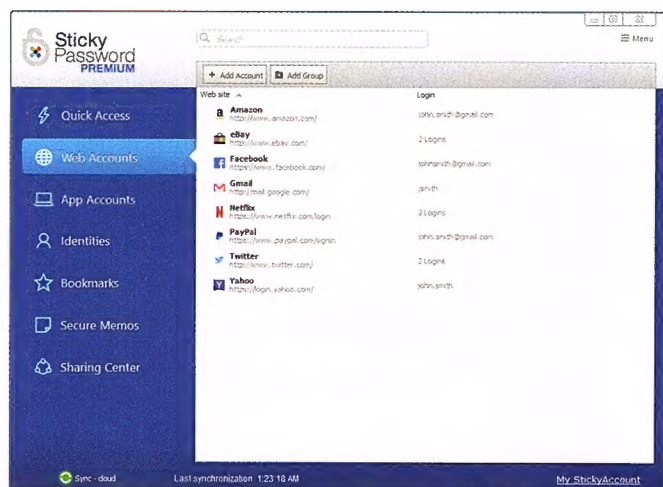
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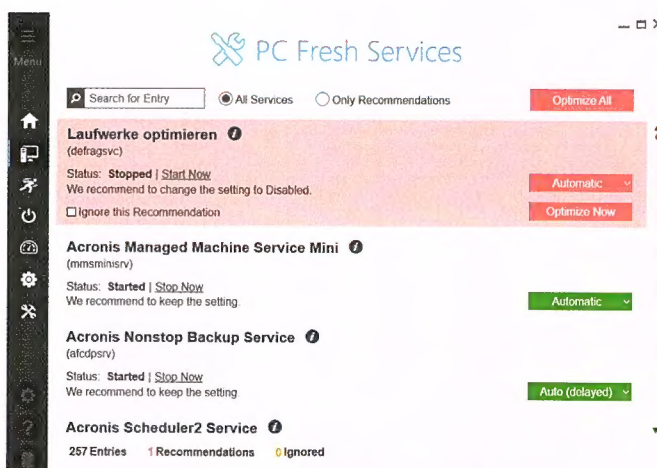
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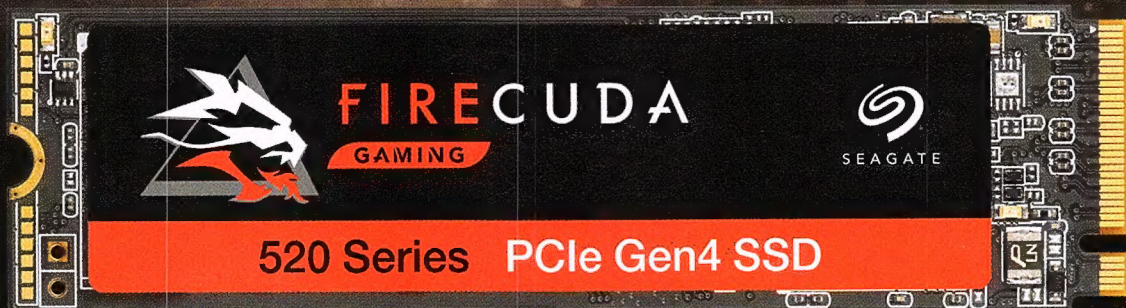
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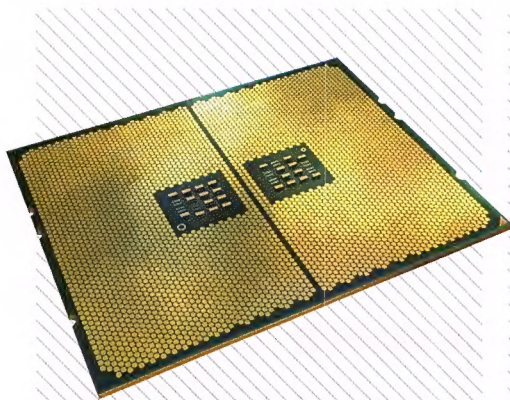
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AMD Ryzen Threadripper 3990X

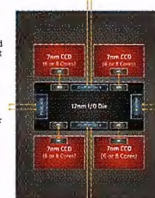
Say hello to the most powerful desktop processor ever.

AMD has been going from strength to strength with successive iterations of its Zen architecture, most recently culminating in the ultra-high end Threadripper 3-series. The entry level 24-core 3960X we reviewed last month decimated Intel's entire HEDT lineup, and by some margin. The 3970X 32 model is equally impressive. But, the best was yet to come. Hidden away inside a press deck was a tease of the 3990X, a 64-core flagship behemoth that teased unprecedented levels of parallel computational power. It introduces a completely new paradigm to the consumer marketplace. So powerful is the 3990X, it may be too much processor for consumer level software to handle. Or is it? Let's see what this monstrous CPU can do.

THE PRODUCT
The basic topology of the 3990X is carried over from

its siblings. The 3990X contains no less than nine chiplets which consist of eight 8-core complexes, each of which packs a 32MB L3 cache, for a total of 256MB. The core complexes for CCDs are built on the 7nm process, which is a major reason why such a dense design can be packed into a relatively small package. The CCDs are joined by a central I/O die which is built with the older 12nm process. Overall the CPU packs in over 33 billion transistors. It's astounding feat of engineering when you consider that Intel, with all its \$400 budget, will be using 14nm monolithic dies for the foreseeable future.

The 3990X operates at a base frequency of 2.5GHz but can boost up to 4.5GHz when thermal and power conditions allow it. You also get 64 PCIe 4.0 lanes, which when combined with those available from the TRX40 chipset, brings it to a total of 72 lanes. All the TRX40



boards seen to date have been especially feature rich. There's no need to worry about what happens if you populate a lot of different PCIe slots or equip a number of M.2 drives or SATA devices, they will all run together at the same time with very few compromises. The 3990X supports quad channel memory with up to 256 GB possible over eight slots.

PERFORMANCE
At \$6,499 the 3990X CPU is a very expensive CPU, and that means you've got every right to expect top level performance to match its price tag. As the 3990X is a desktop CPU, we won't go and compare it to enterprise EPYC or Xeon Platinum

CPUs, though as you'd expect, testing like this leaves the 3990X in a mostly lonely position atop many of the benchmark charts. But, and this is a very big but, the 3990X is simply too good. That 'big but' is that a lot of software doesn't perform too well on the 3990X. Even the

AMD's pretty fabric architecture allows such a large number of cores to operate in a single package

Asus ROG Zenith II Extreme Alpha

APC REVIEW

Nzxt Kraken X73 AIO Liquid Cooler

APC REVIEW

HP Elite Dragonfly

APC REVIEW

Inside APC

Find out all about APC's editorial policies, test practices, how to read the benchmark results, and more.

APC is Australia's oldest consumer technology magazine – having been consistently in print for over 35 years, since our first issue way back in May 1980 – and we take that heritage and responsibility very seriously. While our focus is obviously on the personal computer – it's in our name, after all – the very definition of the PC has changed and shifted markedly since the early 1980s. As such, we touch on many other areas of tech, too, from smartphones and apps to peripherals, accessories, online services and beyond. We have two main goals: to track down the best of modern tech and also to help our readers make the most of it.

We're also an open church in terms of platforms. We know most people aren't wed to a single brand's products and use a variety of devices. And, like you, APC's journalists want to know what's good in tech – no matter what platform it resides on.

INDEPENDENT REVIEWS

Championing technology doesn't mean we're unrelenting yes-men and -women, however, and APC aims to be as objective as possible in all our coverage. That means identifying the best products from multiple perspectives – the best performance, best value and best features and, ideally, the products that offer the best mix of these three.

As a matter of policy, reviews published in APC are not shared with product-makers prior to print. We will contact vendors under certain conditions; for example, if we have a problem testing a product that seems to indicate it may be faulty, or to invite a vendor to clarify how a particular feature works. If an APC reviewer has any potential conflicts of interest involving a brand, the review will always be assigned to another writer.

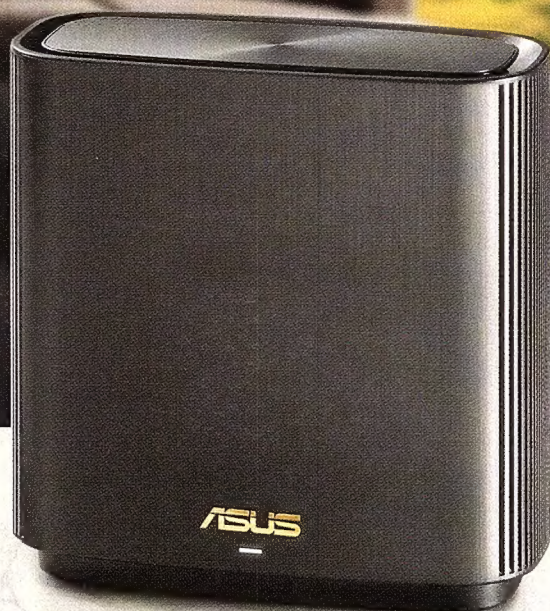
LABS TESTING

Despite being a small magazine with limited resources, APC still strives to conduct the most rigorous, objective scientific tests and benchmarks we can so as to make our reviews as unbiased as possible. We use a variety of tools and programs for this, including many freely available benchmark suites for assessing media encoding, general system performance, gaming and battery life.

In most cases, for the benchmark results published in APC, you can assume that higher is better. There are certain tests that deviate from this rule where the opposite is true; in those cases, we've flagged the results with a note explaining as such.

We use both tables and graphs for displaying results; the latter are our preference due to their ease-of-readability, but tables are more compact, so we use these in cases where thoroughness is preferred.

ASUS



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coverage up to



For more information, scan the QR code or visit:
www.asus.com/au/Mesh-WiFi-System/ZenWiFi-AX-XT8

*Actual data throughput and coverage will vary from network conditions and environmental factors.



Windows Defender

Microsoft Defender on the way for iOS and Android

WILL HELP PREVENT MALWARE AND PHISHING ATTACKS.

Microsoft Defender is on its way to iOS and Android devices. The protection software should be on the mobile platforms by the end of year. The software will focus on preventing malware and phishing attacks. Rob Lefferts, a Microsoft corporate vice president, said that iOS and Android are "pretty safe," stating, "They're pretty safe, but pretty safe is not the same as safe."



Apple will put Arm-based CPUs in Macs within 18 months

CUTTING INTEL OUT?

Apple might be ready to ditch Intel's CPUs by the first half of 2021, according to analyst Ming-Chi Kuo. *9to5Mac* reported that Kuo sent a note to clients predicting Apple's switch to using its own chips in Mac products rather than continuing to purchase CPUs from Intel. That might allow the company to design its own chips for its entire product stack, from the iPhone and iPad to MacBook laptops and desktop Mac products, in the future.

Apple settles slow iPhones lawsuit for US\$500 million.

A WIN FOR CONSUMER RIGHTS.

Apple will pay up to US\$500 million in a class-action settlement, ending litigation that accused the Cupertino company of slowing down older iPhones when it releases new models every year. Customers argued their iPhone's performance declined after installing annual Apple software updates, or new iOS editions. This made them feel their phones, some of which were less than three years old, required new batteries or replacements entirely.



Announcing the 2020 Australian PC Awards

GIVING THANKS TO THE GREATEST GEAR.

Each year the team at APC, along with our fellow techies on our sister titles *TechLife*, *TechRadar* and *PC PowerPlay* gather to acknowledge and reward the very best gear of the year. Thus, the 2020 Australian PC Awards are underway. Across a mammoth 33 categories we shall determine the very best of the best, covering PCs, laptops, and all of the important components and peripherals.

This year we're introducing the Excellence Award, which will go to 'the person, product or technology that advanced the PC more than any other in 2019.' Exciting stuff! Especially so because 2019 saw some big leaps ahead in many areas.

We're putting on a big and fancy awards night on April the 2nd, attended by as many of the tech industry as possible, that aren't grounded by the coronavirus... And, the following day we will publish all of the winners right here: www.techradar.com/au/australian-pc-awards, and we'll have them all listed in the next issue of APC, too.

Honeywell reveals plans to launch world's most powerful quantum computer

CUSTOMERS WILL CONNECT DIRECTLY TO HONEYWELL TO USE IT.

Honeywell has announced that it will release the world's most powerful quantum computer by May, and customers will be able to connect directly to it via Honeywell or on Microsoft's Azure Quantum platform. This machine will be more than twice as powerful as IBM's Q System fleet, and Honeywell also announced that it is on track to increase the capabilities of its quantum computer by an order of magnitude each year for the next five years.

CEO and chairman Darius Adamczyk explained how quantum computing has the potential to transform how things are done across a number of industries, saying: "Quantum computing will enable us to tackle complex scientific and business challenges, driving step-change improvements in computational power, operating costs and speed. Materials companies will explore new molecular structures. Transportation companies will optimise logistics. Financial institutions will need faster and more precise software applications. Pharmaceutical companies will accelerate the discovery of new drugs. Honeywell is striving to influence how quantum computing evolves and to create opportunities for our customers to benefit from this powerful new technology."



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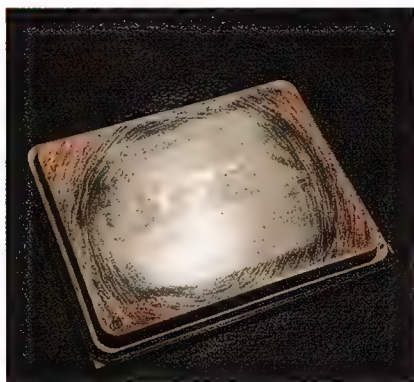
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Deco X20 / X60

All Deco units can be mixed and matched to create your ideal network!
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Overclocked Threadripper 3990X decimates world records

64 CORES AT 5.7 GHZ.

Pro overclocker Allen 'Splane' Golibersuch has shattered ten world records in a single high-intensity overclocking session. Golibersuch managed to get the TR3990X running at 5.749GHz from its stock boost speed of 4.3GHz. In one benchmark the overclocked 3990X on chilled water was almost as fast as \$15,000-worth of AMD's Epyc CPUs that have twice the threads and cores.

Apple may have a 14-inch MacBook Pro coming later this year

REPUTABLE APPLE ANALYST, MING-CHI KUO, HAS MADE HIS PREDICTION.

Apple has done away with the 15-inch MacBook Pro in favour of a bigger 16-inch display, and now it seems likely Apple will do the same for its smaller model. Kuo predicts we'll be seeing a 14.1-inch MacBook Pro land later in 2020, with improved scissor switch keyboard, a mini-LED display, and 10th-gen Intel Ice Lake processors.



Google IO 2020 has been canceled over coronavirus

THOUGH WE MAY SEE IT LIVE DIGITALLY.

Google IO 2020, a conference that was slated to run from May 12-14, has been canceled over coronavirus concerns, but it might live on in digital form. "Over the coming weeks, [Google] will explore other ways to evolve Google IO to best connect with our developer community" read an official statement emailed to confirmed attendees.

Windows 10 is still broken thanks to a recent update from Microsoft

HERE'S HOW TO FIX IT.

In a depressingly familiar turn of events, a recent Windows 10 update (KB4535996) has ended up causing serious issues for the people who installed it. People have been encountering random freezes, installation problems, and even the dreaded Blue Screen of Death. Thankfully, this update is listed as 'optional' by Microsoft, which means your PC won't automatically install it – in fact, you need to go into the Windows Update section of the Settings app to find and install it manually. That should mean that the number of people affected by this faulty update should remain relatively low.

However, if you have installed the update and are experiencing problems, then the way to fix them is to uninstall the update. To do that, open up the Settings app (the cog icon in the Start menu, or by pressing Windows + I on the keyboard), then click 'Update & security'. From the window that appears, click 'Windows Update' on the left-hand menu, then 'View update history'. Click 'Uninstall updates' then select KB4535996 to uninstall it. The problems should now be fixed.



Xbox Series X: will it be worth the upgrade?

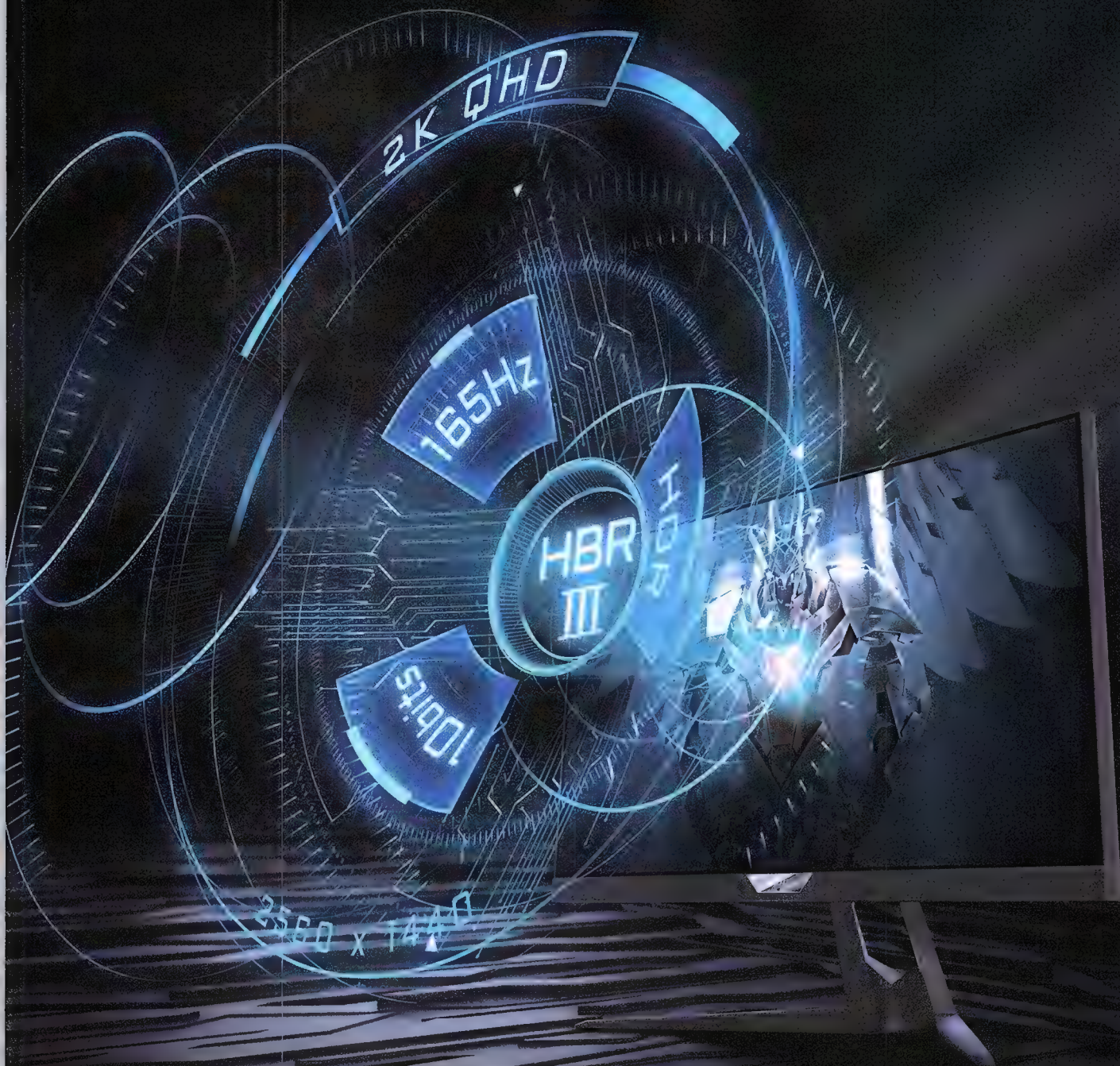
MORE SPECS RELEASED.

More details are emerging from Microsoft on the next Xbox, the Xbox Series X. Both Sony and Microsoft are being coy on price, and for good reason. The Xbox Series X price and the PS5 price came out on top in a Twitter poll of the most important factors for those looking to pick up a next-gen console. Neither company intends to repeat the mistakes of the \$829 PS3 in 2006, or that of the original \$599 Xbox One. Some rumours have suggested the next Xbox will be around \$749, but that's just speculation.

Xbox Series X specs details are hotting up, and they paint an exciting picture for next-gen gaming. Here's what we know so far:

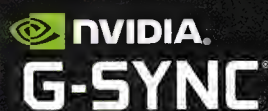
CPU: Custom-designed AMD Navi/Zen 2, **GPU:** 12 teraflops, **Frame rate:** 120 fps, **RAM:** GDDR6, **Resolution:** Up to 8K, **Optical:** Disk drive, **Storage:** SSD

With a 12-teraflop GPU capable of up to 120 fps, the Series X is twice as powerful as the One X. It's also got the computing muscle to support ray tracing, the demanding lighting tech only available on cutting-edge PC graphics cards right now.



NEW AORUS MONITOR LINEUP HAS LANDED!
FI27Q & FI27Q-P

HBR3 allows you to enjoy 2K, 165Hz, HDR, 10 bits color AT THE SAME TIME



▲ LEARN MORE

GIGABYTE



The coronavirus effect

TrendForce expects coronavirus to hurt supply of notebooks, monitors and more.

TrendForce said that it expects the Coronavirus outbreak to cause lower-than-expected shipments of notebooks, monitors and other products in the first quarter of 2020 as manufacturers struggle to resume normal operations.

The research firm predicted that numerous product categories, from smartphones and smart watches to notebooks and monitors, will ship fewer units than originally anticipated. The actual change in its forecast varied from category to category.

Smart watches are expected to have it worst, for example, with a revised forecast of 12.1 million units shipped instead of 14.4 million. TVs are expected to have it better: TrendForce predicted a 4.5% drop from 48.8 million to 46.6 million units.

Other categories landed somewhere between those extremes. Of particular note are the declines for notebooks (12.3%), game consoles (10.1%) and monitors (5.2%). All three were expected to be hit by manufacturing delays or component shortages.

Here's what TrendForce had to say about notebooks:

"The downstream ODMs and brands in the supply chain are undoubtedly hit the most by the coronavirus outbreak. These companies lost precious working days after work resumption was postponed. After their production is resumed, on a whole, operators' work resumption rate is low. Besides, all types of materials and components are in shortage. Hence, productivity plummets.

"To assemble a notebook set requires complicated key components. At the current stage, notebook batteries, hinge, and PCB already experienced shortage or out of stock. This factor might cause some brands' shipment quantity to remarkably drop from previous prediction (35 million units) to 30.7 million units in 1Q20."

TrendForce wasn't alone in predicting supply issues for notebook makers. *DigiTimes* said that laptop (and smartphone and semiconductor) manufacturers were struggling to resume normal operations because of the Coronavirus outbreak.

The only category TrendForce didn't seem worried about was memory products. Companies stockpiled memory in anticipation of the Chinese

New Year, which helps, as do the highly automated nature of these fabs and their shipping clearances.

Here's the good news: TrendForce currently believes that most of these product categories will be able to quickly recover from their problems in the first quarter. Assuming, of course, that the Coronavirus outbreak is resolved sooner than later.

Meanwhile, *Bloomberg* reported that Nintendo might struggle to meet demand for its Switch console due to supply problems caused by the ongoing Coronavirus outbreak.

Switch consoles shouldn't be hard to come by in the short-term, *Bloomberg* said, because Nintendo's already shipped all the units it expects to sell through March. But current supply constraints might lead to a global shortage as early as April.

Nintendo wouldn't be the only gaming company facing a product shortage as a result of Coronavirus. Facebook said earlier this month that its Oculus Quest headset was affected by the outbreak, for example, and the product still hasn't been restocked. ■

Nathaniel Mott



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» GIZMOS AND GOODIES.

VIVE COSMOS

A new universe of VR headsets from Vive.

FROM \$1,299 | VIVE.COM/AU

The Oculus Quest has consumed a lot of the air in the VR space recently so it's good to see that HTC is hitting back with some creative VR updates. In addition to offering a solid bump in combined resolution the headsets also come in three variations: the Cosmos Elite, the Cosmos XR and the Cosmos Play. The first is the more traditional headset that includes two external trackers and a different faceplate for superior motion tracking. The Cosmos XR comes with a wide angle camera faceplate that allows a superior 100-degree field of view for stand-alone AR experiences. Finally the Vive Cosmos Play offers a four-camera inside-out tracking faceplate that makes a great standalone VR headset that can be upgraded to PC VR capable later.



KOLUDE KD-K1 KEYBOARD HUB

This minimalist keyboard will make the laptop hub obsolete.

US\$119 | KCK.ST/2GV6YSU

If you've bit the bullet and bought a fancy ultrabook recently, chances are you've been disappointed by its connectivity options. This is a shame since today's laptops are more than powerful enough to use at home as your primary device too, but to do this you need a hub to connect everything to... or you did. Kolude KD-K1 is a Kickstarter that hopes to integrate a full USB-C hub into a slimline professional keyboard. The keyboard only offers throughput speeds of 5Gbps (USB 3.0) and 4K at 30Hz is the maximum display output, but it adds a microSD, SD card reader, 3 USB 3.0 ports and a USB Type-C output.

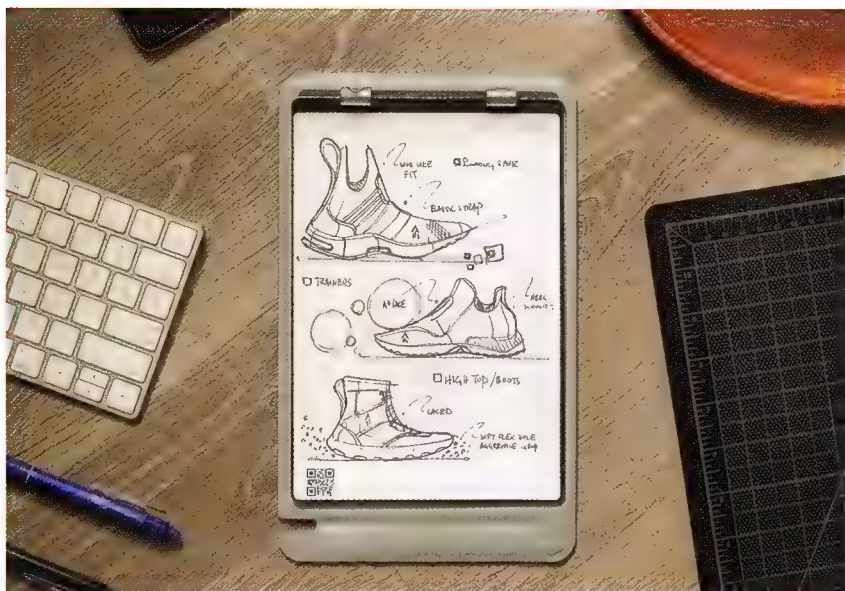
XBOX SERIES X

The console continues.

\$TBC | XBOX.COM

If you still prefer to play your games in the living room then you're probably keenly eyeing off the next generation of consoles. In February we got a closer look at Microsoft's plans for the Xbox Series X, slated to launch sometime before the end of 2020. Details are still a little scarce, but what we do know is that it'll come with 120fps support, the potential for 8K output, faster SSD storage, compatibility with existing accessories and a custom-designed AMD processor that will be twice as powerful as the Xbox One X.





ROCKETBOOK ORBIT

The SpaceX of notepads.

US\$29 | GETROCKETBOOK.COM.AU

The team that managed to make a crowdfunding success of microwavable reusable notebooks are back on Kickstarter with a new never-ending notebook. The Rocketbook Orbit turns the page on reusable notebooks by introducing a new ink that dries quickly and wipes clean with a wet cloth. As the name may suggest, the Orbit's key feature is that it works like a clipboard allowing you to fold or flip pages to make it faster to continue with your note taking. When you're done simply use the app to scan the pages and then wipe them back to start all over again.

SAMSUNG T7 TOUCH

The next generation of fast, secure storage.

FROM \$279 | SAMSUNG.COM

Samsung has really shaken up the portable SSD market over the last couple of years and its latest SSD the T7 Touch is about to do it again. The T7 touch uses a PCIe-connected SSD and the latest USB 3.2 specification to achieve read and write speeds of over 1000MB/s, which is more than double the maximum speeds of traditional SATA3 connected external SSDs. While the new portable storage device holds back on the full dual-lane USB 3.2 connection offered by WD's P50 Black drive, in most circumstances (where you don't have the absolute latest USB ports) it'll be just as fast and a little less expensive. Plus it has a fingerprint sensor to keep all your CryptoKitties safe.



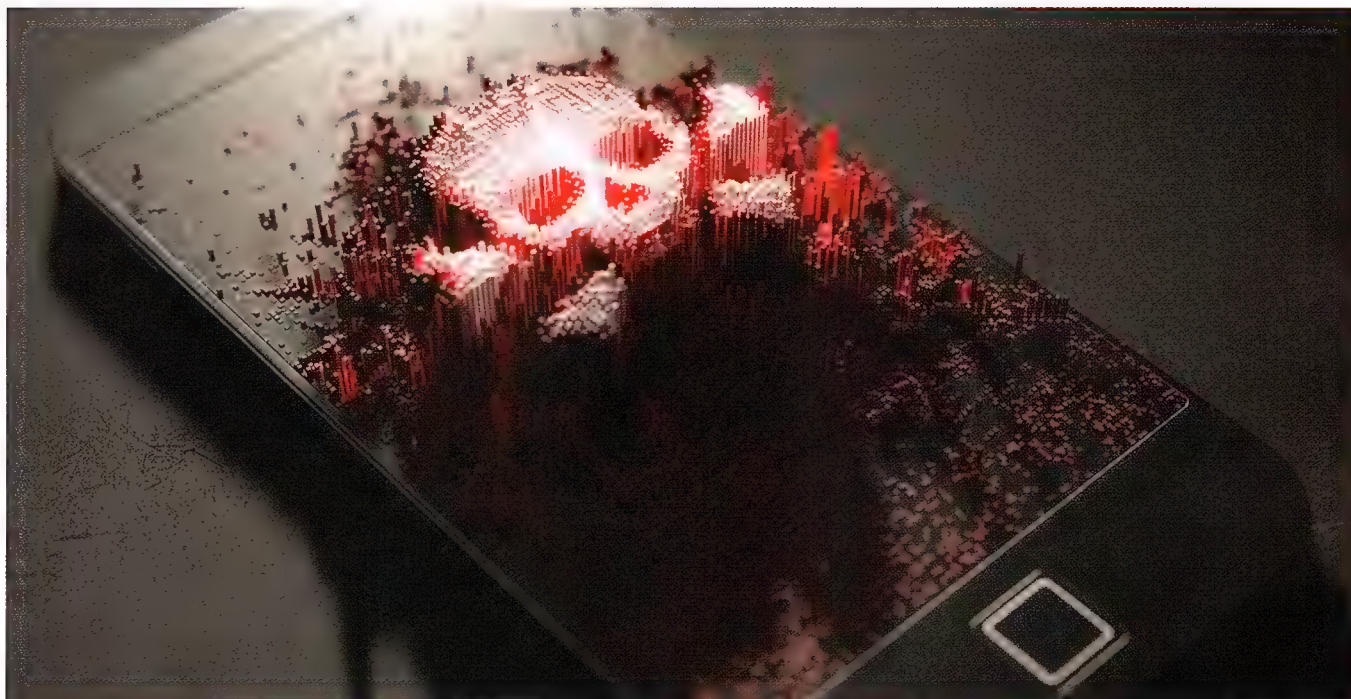
TECHNICS EAH-F70N

Technics enter the premium consumer ANC headphone market.

\$599 | TECHNICS.COM/AU

The Audio brand known for its high quality turntables has turned its attention to the premium ANC headphone market with a product that offers all the perks of Sony's WH-X1000s or Bose's QC35s. Naturally, Technics has made audio quality its primary focus with big 40mm neodymium drivers that can reproduce sounds from 4Hz - 40,000Hz. While the wired connection still offers the best audio quality, the EAH-F70N does include LDAC 96kHz/24 bit wireless audio transmission over Bluetooth. On the noise cancelling front Technics has met the industry standard of having three noise cancelling options: active, passive, and audio passthrough so you have the option to hear your surroundings or nothing at all. ■





What does the Coronavirus mean for the tech world?

COVID-19 may threaten a lot more than just technology.

The COVID-19 Coronavirus is dominating world news. I'll try to steer clear of larger implications of its global spread and leave that to medical experts. Instead I'll try to focus on what it means for the technology industry which at the time of writing, is already seeing significant impacts. Several major companies including Microsoft and Apple have issued revenue warnings, with many more likely to follow.

The spread of the Coronavirus has resulted in large scale quarantining, travel bans, disruption of global supply chains, a stock market meltdown and a general increase in negative economic sentiment amongst many other effects. All of this is having a direct impact upon the global technology industry, the effects of which have yet to be understood.

Consider the disruption to global supply chains. A phone is useless without a screen. China is such an important cog in the world economy. If component shortages begin to bite, we could see situations where some everyday tech items are simply unavailable. Reports are that Chinese manufacturing has ground to a

complete halt in many provinces. While most companies have inventories that allow them to absorb a short term shock, longer term shortages have deep ranging effects.

South Korea too has been hit hard with its number of infected rising every day. Korea is a vital production base for all sorts of technology, with the likes of Samsung, LG and SK Hynix all being affected. DRAM and NAND flash memory sourced from Korea can be found in smartphones, tablets, laptops and PCs, and if supplies of these start to dry up, significant price rises can be expected.

There are precedents. One of the historical cases of supply chain disruption was caused by heavy flooding in Thailand in 2011 which led to a global shortage of hard drives that persisted for over a year. Bear in mind that only a part of the global HDD manufacturing capacity was affected. The disruption caused by the Coronavirus has the potential to be much worse than a once-off blip in a single country. It really is looking likely that all kinds of common technology items will see shortages and price increases.

We're seeing trade shows and conferences being affected. Already several large events have been cancelled including Mobile World Congress and the Game Developers Conference. Perhaps we'll see Computex in early June cancelled, not to mention other global events like the Tokyo Olympics.

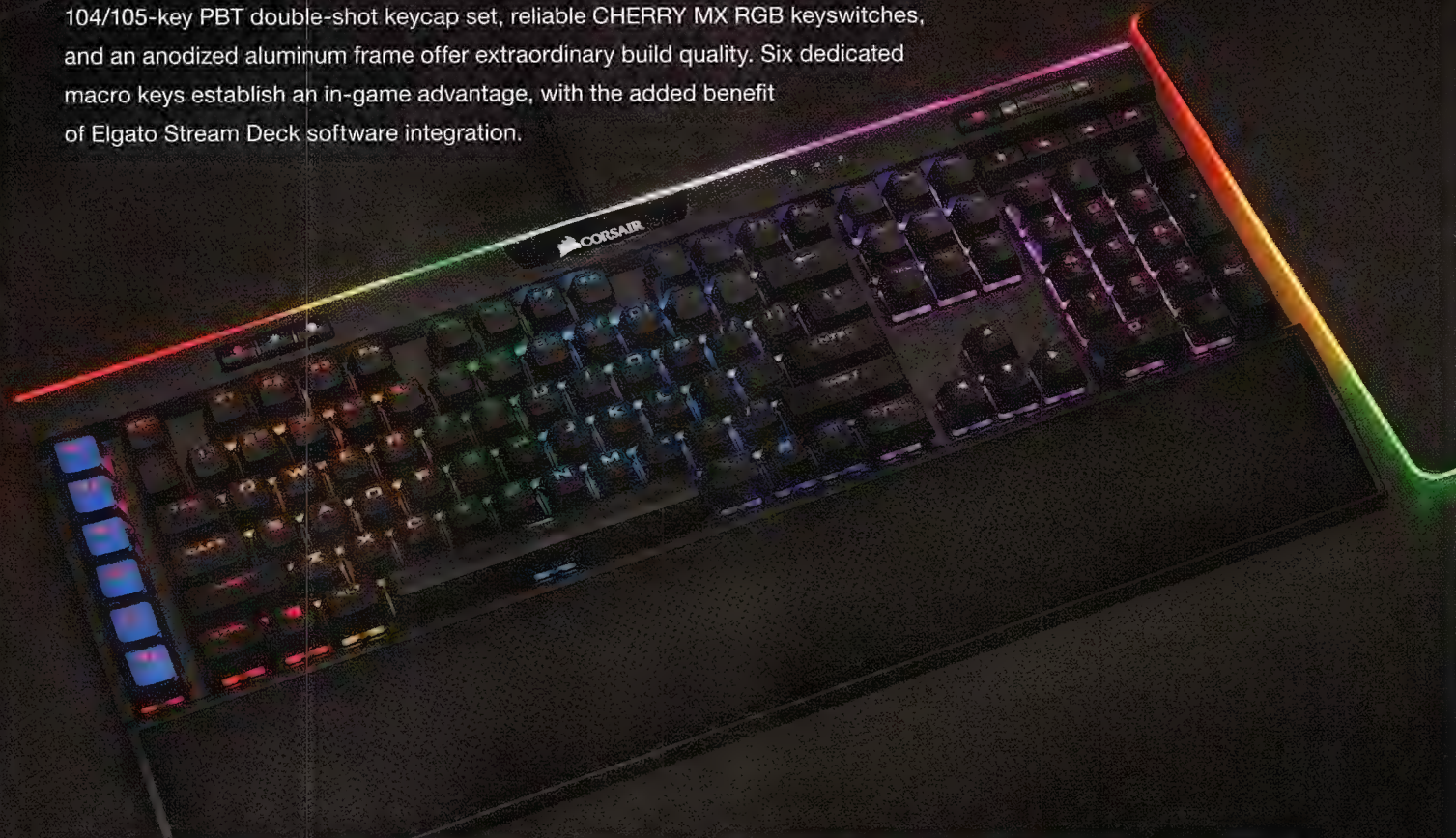
The Australian dollar's exchange rate is taking a beating too. This directly leads to a rise in the price of imports, and with such a large percentage of Australia's electronics being imported, expect retailers take a hit, not to mention the increase in business costs.

It's too early to say what kind of long-term effects the virus will have. It's something that will take years of academic research to quantify. What's already becoming clear though, is that global supply chains are highly vulnerable to shocks. It may be too late to save the global economy from a crisis that makes the 2008 Global Financial Crisis look like a blip. Then again, perhaps there's nothing to fear except fear itself and COVID-19 will end up as a short term disruption like the SARS virus. Let's hope it's the latter. ■



PLAY WITH A FULL DECK

The CORSAIR K95 RGB PLATINUM XT Mechanical Gaming Keyboard immerses your desktop in dynamic RGB lighting with per-key illumination. Precision-molded 104/105-key PBT double-shot keycap set, reliable CHERRY MX RGB keyswitches, and an anodized aluminum frame offer extraordinary build quality. Six dedicated macro keys establish an in-game advantage, with the added benefit of Elgato Stream Deck software integration.



K95 RGB PLATINUM XT

Mechanical Gaming Keyboard



Game streaming services are having some teething problems

GeForce Now was meant to put Google in its place, instead it's coming slowly undone, writes Shaun Prescott.

It was so promising. When Nvidia unleashed its GeForce Now game streaming service into free beta in February, it did so at a time of widespread anguish regarding Google's Stadia service. Stadia had been (and still is) harried by a number of problems, chiefly a lack of new games and updates, as well as sporadic controversies concerning the visual quality of its library.

The GeForce Now proposition was, on paper, much better: you didn't buy games from Nvidia per se. Instead, you were able to stream games anywhere based on whether you already owned them on Steam. In other words, if you wanted to play *Call of Duty: Modern Warfare* away from your crash hot gaming PC, you could do so on a smartphone or laptop using GeForce Now. There were restrictions: the free 'standard access' only allowed one hour play sessions, but once that was up you could rejoin the queue to jump back in (the five dollar tier prioritised your place in this queue and provided longer sessions).

It seemed to eradicate one of the main problems with Stadia, which charges full price for games you do not in a traditional sense "own". They're hosted by the cloud, and if that cloud happens to disappear, then you've lost your game forever. With GeForce Now came the peace of mind that any software bought wasn't at the mercy of the streaming service's health.

But then it started to come apart. On February 14, Nvidia announced that all Activision Blizzard games – ranging the aforementioned *Modern Warfare* through to *Overwatch* and *Diablo 3* – would be suddenly removed from the service. Then, several days later, all except one of Bethesda's games were pulled.

This is all due to misunderstandings



"On February 14, Nvidia announced that all Activision Blizzard games – ranging the aforementioned *Modern Warfare* through to *Overwatch* and *Diablo 3* – would be suddenly removed from the service."

on the contractual end: Activision (and presumably Bethesda) were signed up during the service's free limited beta, but when the service went larger scale, adding the five dollar tier, the game changed and they pulled out. More odd, is that several independent developers have pointed out that they had never actually agreed to appear on the service to begin with.

But the business end of the matter isn't of much concern to us: what matters is that the GeForce Now scenario plays into some of the enduring misgivings concerning cloud services, namely, that as a consumer you can really have no guarantee that the games you want to play will stick around. While Nvidia isn't a software

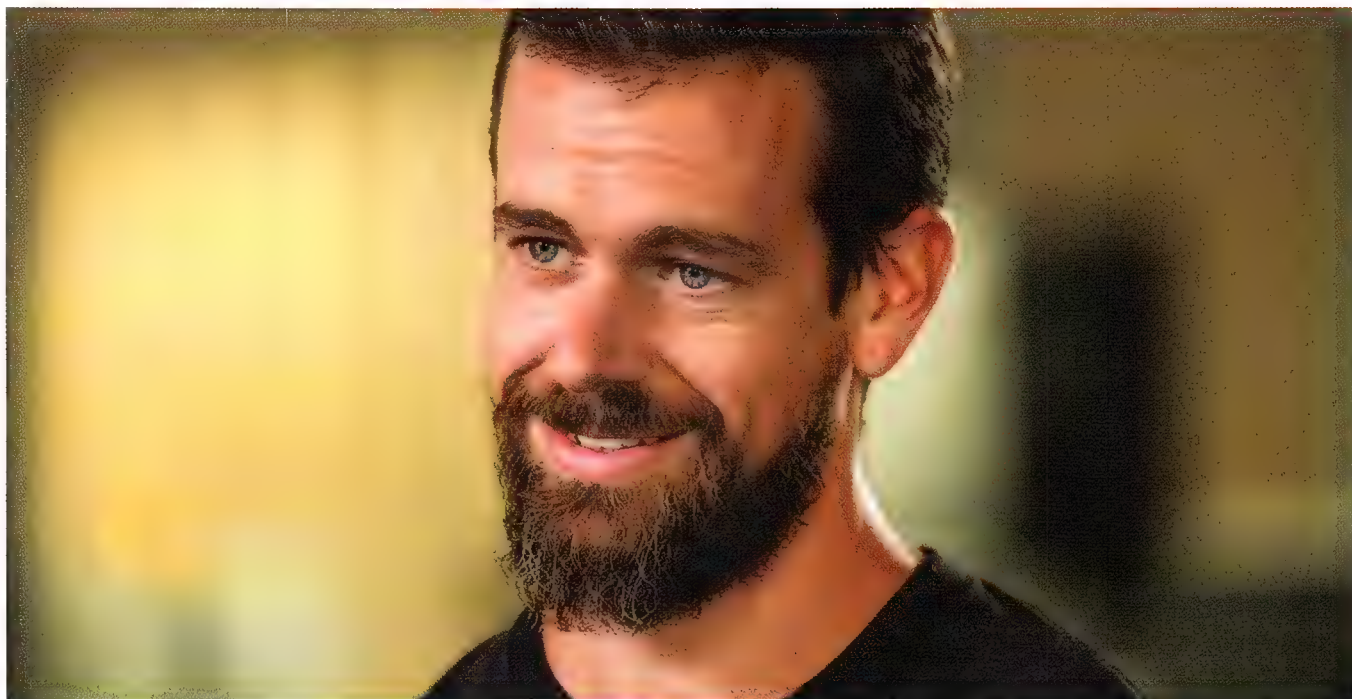
vendor, in that it didn't sell game licenses, it's reasonable to assume that, in the future, some will buy Steam games on low-spec machines in order to access the streaming services Nvidia offers.

But who except those with money to burn would dare do so, at this stage? The streaming wars are only just starting in the games space. Rumours are afoot that Sony's PlayStation Now service will launch in Australia some time this year, and Microsoft won't let its xCloud tech languish. Meanwhile, don't expect the likes of Amazon to sit on its hands while others are making the big bucks. Streaming is real and here to stay, but it doesn't seem a wise investment for consumers at this stage. ■

Share your stories!

If you have an interesting story about technology users, their experiences and the issues that affect us all (whether funny or serious), email us at apcmag@futurenet.com. All correspondence becomes the property of APC and is subject to editing. Letters must include writer's full name, street address, suburb, state and phone number to be considered for print publication. Address and phone details will not be published.

» JOEL BURGESS STEPS INTO THE FRAY.



Trump megadonor tries to out Twitter co-founder

Twitter CEO Jack Dorsey looks to be top of the agenda for activist investment firm Elliott Management. Joel Burgess ponders the implications.

If you've ever listened to a Trump rant, you'll be aware of his tendency to blame things on his opponents, no matter how ridiculous or implausible, so it's perhaps not so surprising that he blames any loss of Twitter followers on platform bias against conservatives. While it's one thing to say this without any foundation, it now seems like some of the conservative movers and shakers are planning to take action to make sure their side of the story is heard, much louder and much clearer than any others, even if that was already the case.

In February *Bloomberg* broke the news that activist investment group Elliott Management Corp. bought a big chunk of Twitter's stock in a move that looks a lot like a hostile takeover. Elliott Management's stake in the microblogging site gave it four chairs on the board of directors, and while it isn't known exactly how much sway this will have, Twitter only has one class of stock, which means the co-founder and CEO Jack Dorsey does not have final voting control over the board (unlike many other Silicon

Valley social media companies). The *Bloomberg* report quoted sources close to the matter as indicating that it was Elliott Management's plan to "push for changes... including replacing Dorsey."

Billionaire founder and CEO of Elliott Management, Paul Singer, donated US\$240,000 to a Trump reelection campaign in 2018, despite being originally opposed to Trump's appointment in 2016, with Trump even confirming at a White House visit in 2017 that "Paul[s]... given us his total support". Given the close relationship with the Republican Party and the fact that Elliott Management has a track record of using its investments to push shifts in companies like Ebay, AT&T, Marathon Petroleum Corp. and Pernod Ricard SA, it would not be uncharacteristic of the investment firm to push changes that are more aligned with the aspirations of the conservative party.

Twitter is the US President's platform of choice for getting around the media to talk directly to a large audience, and he publicly accused it of showing anti-conservative bias in 2018

after losing followers, so it makes sense that it would be a potential target for political manipulation. Although a number of studies, some even funded by conservatives, couldn't find any bias on any of the social media sites tested, the lack of factual support hasn't seemed to curb the rhetoric.

Twitter did make headlines in October 2019 for banning all political advertising, a decision that contrasted starkly with Facebook's decision to not only allow political ads, but to also exempt them from the same fact checking standards as all other types of ads on the site. It also explicitly outlined its plan to combat election disinformation and 'manipulated media' like deepfakes ahead of future US elections.

A lot of this is still speculative, since at the time of writing both Elliott Management and Twitter declined multiple media requests to comment on the issue, but regardless there are some massive changes on Twitter's horizon. We'll just have to hope they're not as concerning as what's been happening at Facebook. ■ Joel Burgess

numbercrunch

» WE LOOK AT THE NUMBERS DRIVING THE BIG TECH NEWS.

54.62%

The proportion of PCs running Windows 10 in December 2019, according to figures from NetMarketShare. Windows 7 came in at 26.64%, with Windows 8.1 on 3.63%, and Windows 8 on 0.66%.

0.6%

The year-on-year growth in the Windows PC market for 2019, from Gartner analysis. It was the first year since 2011 to see all-quarter growth.

270 MILLION

The number of times the WhatsApp messaging app was downloaded in the last quarter of 2019, according to figures from app analysis firm Sensor Tower. 30 million came from Apple's App Store, with Google Play making up the rest.

333 MILLION

Is the number of smartphones shipped in just one quarter of 2019 according to figures from analyst IDC, dwarfing PC shipments of 72 million in the same time period.

9.1%

The growth in phone app downloads in 2019, from the Sensor Tower analysis.

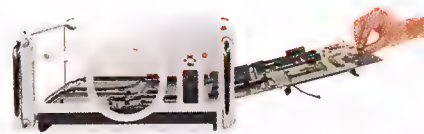
23%

Proportion of people surveyed who gave the reason 'not interested' as to why they didn't want to go to the moon. 11% of lunar refuseniks thought there was not enough to see or do there.

how it's done



The Mac Pro 2019, before we started pulling its insides out.



Even by EATX standards, this board is huge, reminding us more of an Xbox board than ye olde 2013 Mac Pro.



Mac Pro 2019

When almost everything is done right.

The Mac is back and more Pro than ever, throwing away the “trash can” design in favor of something that resembles a computer. Its appearance may hark back to 2006’s original, but can it compare in the repairability department?

MAJOR TECH SPECS

- Eight-core Intel Xeon with 24.5MB of L3 cache and a 4.0GHz max turbo frequency
- 32GB (four 8 GB modules) of 2,666MHz DDR4 ECC memory
- AMD Radeon Pro 580X with 8GB of GDDR5 VRAM
- 256GB PCIe-based flash storage module
- 802.11ac Wi-Fi and Bluetooth 5.0

KEY FINDINGS

- We brought plenty of tools, but so far all we need is our fingers. Informative dots tell us the handle rotates, and with ease. The housing slides off with little effort. Inside, we get a peek at the familiar-looking locking mechanism. A closer look reveals pogo pins under the power button that correspond to contacts on the housing. Removing the housing breaks the connection, cutting the power. Neat!

- Unfazed by the ominous array of black modules in the case, we pull the first switch we can find, and voilà! Up pops the first memory cover, revealing two of the four sticks of RAM that came with our model (there’s room for eight more). Still no tools required – if you have opposable thumbs, you can replace this RAM. The cherry on top is the diagram on the insides of the RAM covers, showing which DIMM slots to populate with different amounts of memory.
- The I/O boards are held in place by Phillips thumbscrews and can be loosened (and tightened) by hand. All PCIe cards are locked in place by a single switch that moves a rail with hooks on it that secure anything in their path.
- The I/O board, video card, and power supply all come out from the same side of the case. We stop to admire all the numbers indicating the order of operations. The power supply is the last easily removable module to come out. It’s held in place with a single T8 Torx screw.
- Let’s take a look at the custom AMD Radeon Pro 580X video card module: When you pull the release latch, it engages two rollers on the other side,

which undock the card and push it away from the motherboard. Unlike the module itself, the silicon inside does not come out with a clever lever. A few screws are hidden under a giant sticker on the cooling fins, and we have to carefully disengage the lever mechanism before we can finally pull out the card.

- Removing the blower fan housing reveals a tiny SSD. We’re happy to see a modular SSD, but not happy knowing it’s bound to the T2 chip, so user-replacements are a no-go. That said, there are plenty of other ways to add storage.
- Repairability Score: 9 out of 10 (10 is easiest to repair). Basic repairs or upgrades can be done with standard or no tools. Major components are modular and use industry-standard sockets and interfaces, making replacements or upgrades a snap. Apple provides some step numbers and diagrams on the device, and publishes free manuals for some repairs. The SSD cards are modular, but custom-made by Apple, complicating replacement. If you need a replacement that’s not on Apple’s limited list of approved repairs, you’ll likely pay a dizzying price. ■

Oculus Rift S vs. HTC Vive Cosmos vs. Valve Index

What to stick your head in, in 2020.



VR has come a long way. Some would argue it's not quite there yet (some members of the APC team, in particular), but it's hard to deny that the platform has made leaps and bounds in the past few years. Since Palmer Luckey broke the mold with the original Oculus Rift, several competitors have emerged, most prominently HTC's Vive and the more recent Valve Index. Oculus hasn't been resting on its laurels, though, and tethered VR clearly isn't dead – but which model out right now is the best for you? Let's break it down....

1

Value

Despite its ludicrous \$2,000 price (which is higher for Aussies than in other countries because Valve doesn't officially ship the Index here, so a go-between service like Auspost Shopmate is needed) the Index sold out quickly. Valve restocked, of course, but with *Half-Life: Alyx* looming on the horizon, it sold out again. The price has dropped somewhat since then, though, but it's not even close to the \$1,149 Vive Cosmos or Rift S at \$649.

That significantly lower price doesn't come with any huge drawbacks either. Yes, the Rift S is the oldest of these three headsets, and it has a slightly lower resolution, but it still performs perfectly well when paired with a good VR-ready PC. The Rift S also has the lowest refresh rate of the trio, but only by a small margin. In a sense, you get what you pay for when it comes to VR, but the Rift S is undeniably good value.

Paying more than \$2,000 for a VR solution in a market where all the big players are broadly comparable isn't a great proposition. Both the Index and the Cosmos were criticised on release for being overly expensive, and as long as there are eminently affordable options (such as Sony's best-selling PSVR), those criticisms will remain valid.

2

Controllers

All three VR platforms come with excellent, high-quality controllers. All have proper motion controls and similar button layouts, and the Rift S and Cosmos both utilise "inside-out" tracking systems that use cameras mounted on the headset itself to track the controllers. Full finger-tracking is a feature touted by the Valve Index, the only one to have controllers that properly wrap around the hand.

The controllers on the Oculus Rift S are particularly nice, using touch sensors on the buttons to simulate proper finger-tracking to reasonable effect. The number of games that use finger-tracking is relatively small, though, so it's unclear if this really gives the Index an edge. A few titles (such as Valve's *Aperture Hand Labs* tech demo) show it off nicely, to be fair.

In practice, we favor the Rift S controllers. The Cosmos controllers are very similar in design, but don't sit as comfortably in the hand, and are a bit heavier. The Rift S controllers are the lightest, but the buttons and triggers still feel firm and responsive. The Vive and Rift controllers both look a lot nicer than the weird, jagged Index knuckle controllers, too. Another win for Oculus, then.

3

Design

When we say "design," we're not just talking about aesthetics here. If we were, the winner would be the Rift S again; the Valve Index is pretty fugly compared to the other two, with the Rift S looking sleek and smooth in black, while HTC's latest headset is a truly sci-fi piece of hardware.

The Index might look weird and chunky, but the design extends beyond mere aesthetic value; in fact, given that you'll be strapping your chosen headset over your face, we would go so far as to say that appearance is irrelevant. Design extends to extraneous features like earphones; the Index is equipped with a pair of near-field speakers that are strapped to the headband, hanging just out of reach of your ears. It's a great design choice; zero contact means that extended sessions won't get uncomfortable, and the directional audio quality is phenomenal without cutting off all outside sound altogether.

The Cosmos headphones press against the ear, potentially making for sweaty lobes, while the Rift S has tiny built-in speakers that don't really measure up. Add in the high build quality of the Index (the cushioning is excellent, and the entire headset feels durable) and it's a clear win for Valve.

WINNER: OCULUS RIFT S

WINNER: OCULUS RIFT S

WINNER: VALVE INDEX

From left to right: The Oculus Rift S is the ultimate evolution of the groundbreaking original Rift. HTC's latest headset can be fitted with a wireless adapter. The Valve Index is the newest here.



4

Performance

It's difficult to benchmark tethered VR headsets, as they rely on a PC to power the games. Were we comparing standalone headsets, like the Oculus Quest, which use a headset-integrated processor, this category would likely be easier. As it stands, we're going to have to look at some other elements.

Eye display resolution first: The Oculus Rift S loses out straight away, with 1280x1440 per eye (or 2560x1440 total), while the Index and Vive Cosmos have 1440x1600 and 1440x1700 per eye respectively. The shift in resolution is noticeable between the Rift S and the other two, but the Index and Cosmos are pretty much indistinguishable.

The Index's two displays also have a leg up over the competition in two important areas: refresh rate and field of view. While the Rift S and Cosmos sit at 80Hz and 90Hz respectively, the Index packs a mighty 120Hz refresh rate, with an experimental 144Hz mode for some games. It can make a notable difference, although broadly speaking, as long as it remains above 80Hz, it shouldn't interrupt gameplay immersion. Lastly, the Index has an effective maximum FOV of 130 degrees – significantly more than the other headsets, which are around 110.

5

Ease of Use

As much as we like the Valve Index, it isn't going to win this section. Oculus and HTC have been in the VR game for a while now, and they've learned from their mistakes; in this case, it's the introduction of inside-out tracking that really leaves the Index in the dust. You've still got to set up base stations around your room, and enter the floor height of the room you're playing in, then use the controllers to mark the four corners of the room, then have Steam on your PC calculate a usable play area.... It's a convoluted process that feels outdated and clunky.

The Rift S, however, simply shows you a spooky gray-tinted video feed of your surroundings using the external cameras, and has you paint out a play area using one of the controllers. It takes seconds, and the boundaries fade in unobtrusively if you get too close to the edges.

The Vive Cosmos is almost as good, automatically mapping out walls and corners in your play area to use as markers. It takes even less time than the Rift S, but it's not infallible; if the exterior cameras lose track of the controllers, it takes frustratingly long to reorient them, and low lighting conditions can prove ruinous.

And the winner is...

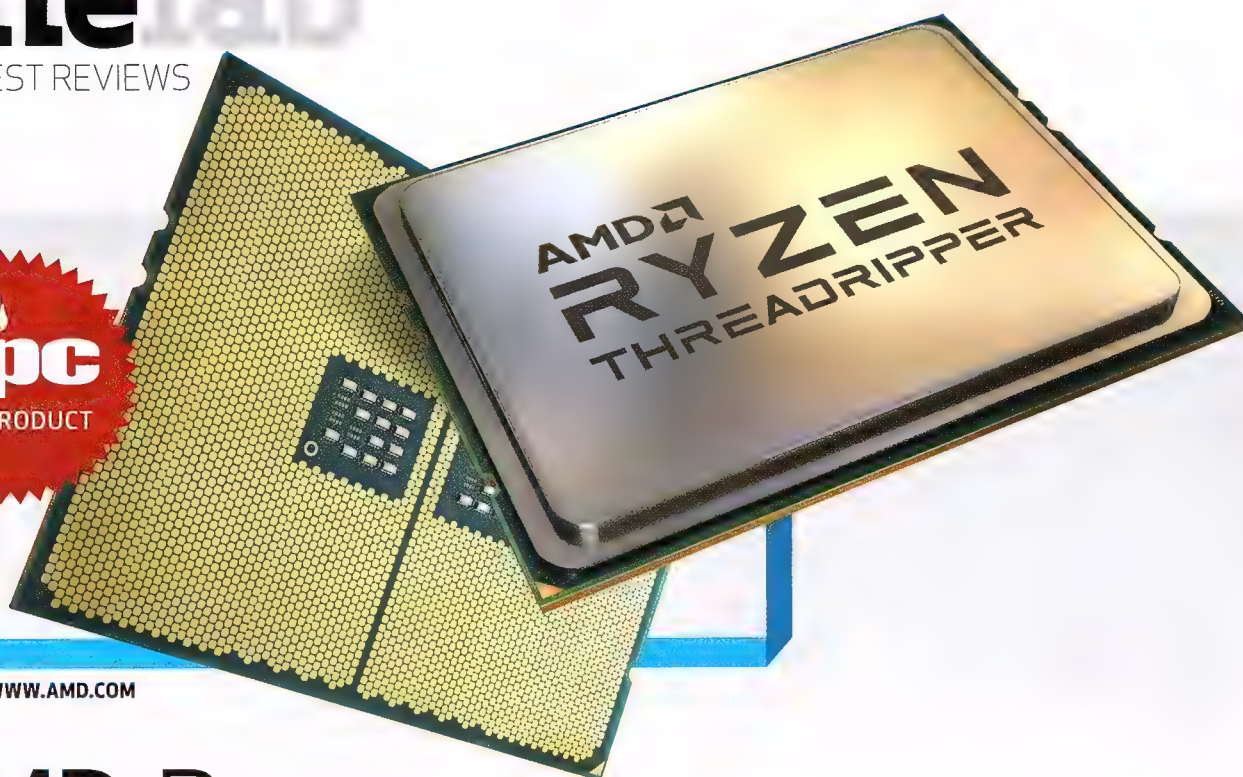
We have to hand it to Facebook, it knew what it was doing when it bought Oculus in 2014. The VR giant has come a long way since the original Kickstarter campaign for the first Rift prototype, constantly at the forefront of what makes VR great.

It's true, the Rift S might be the least powerful piece of hardware on show here, but it's not enough for a VR headset to simply have the latest eye displays. It has to be affordable, and it has to have the support of developers. Oculus was the first on the scene to modern VR, garnering it a decent chunk of the market right off the bat, and the company has kept as much of that as it could.

Yes, the Valve Index is the high-end VR headset right now. The quality of the headset itself is undeniable, and anyone who says that *Half-Life: Alyx* will be best experienced on a different platform is kidding themselves. But the Rift S is far better value, much easier to use, and when it comes down to it, the VR experience is much the same regardless of your choice of headset. All we'd advise is getting a good pair of earphones. ■

WINNER: VALVE INDEX

WINNER: OCULUS RIFT S



CPU

\$6,499 | WWW.AMD.COM

AMD Ryzen Threadripper 3990X

Say hello to the most powerful desktop processor ever.

AMD's Infinity Fabric architecture allows such a large number of cores to operate on a single package.

AMD has been going from strength to strength with successive iterations of its Zen architecture, most recently culminating in the ultra-high end Threadripper 3-series. The entry level 24-core 3960X we reviewed last month decimated Intel's entire HEDT lineup, and by some margin. The 3970X 32 model is equally impressive. But, the best was yet to come. Hidden away inside a press deck was a tease of the 3990X, a 64-core flagship behemoth that teased unprecedented levels of parallel computational power. It introduces a completely new paradigm to the consumer marketplace. So powerful is the 3990X, it may be too much processor for consumer level software to handle. Or is it? Let's see what this monstrous CPU can do.

FITTING THEM ALL IN

The basic topology of the 3990X is carried over from

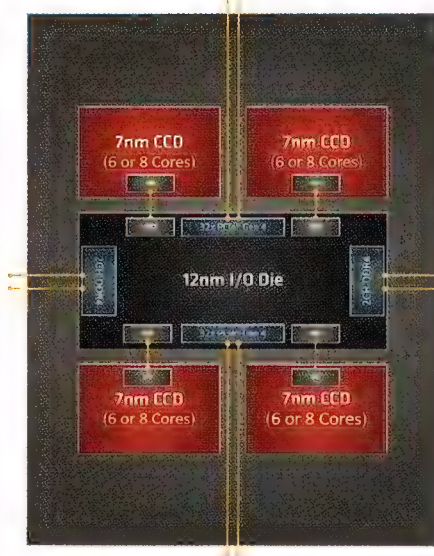
its siblings. The 3990X contains no less than nine chiplets which consist of eight 8-core complexes, each of which packs in 32MB of L3 cache, for a total of 256MB. The core complexes (or CCDs) are built on the 7nm process, which is a major reason why such a dense design can be packed into a relatively small package. The CCDs are joined by a central I/O die which is built with the older 12nm process. Overall the CPU packs in over 33 billion transistors. It's a stunning feat of engineering when you consider that Intel, with all its R&D budget, will be using 14nm monolithic dies for the foreseeable future.

The 3990X operates at a base frequency of 2.9GHz but can boost up to 4.3GHz when thermal and power conditions allow it. You also get 64 PCIe 4.0 lanes, which when combined with those available from the TRX40 chipset, brings it to a total of 72 lanes. All the TRX40

boards seen to date have been especially feature rich. There's no need to worry about what happens if you populate a lot of different PCIe slots or equip a number of M.2 drives or SATA devices, they will all run together at the same time with very few compromises. The 3990X supports quad channel memory with up to 256 GB possible over eight slots.

WHAT IT'S GOOD FOR – AND NOT

At \$6,499, the 3990X CPU is a very expensive CPU, and that means you've got every right to expect top level performance to match its price tag. As the 3990X is a desktop CPU, we won't go and compare it to enterprise EPYC or Xeon Platinum



CPUs, though as you'd expect, testing like this leaves the 3990X in a mostly lonely position atop many of the benchmark charts. But, and this is a very big but, The 3990X is simply too good.

That big 'but' is that a lot of software doesn't perform too well on the 3990X. Even the

BENCHMARK RESULTS

	CINEBENCH 20 - MULTI THREAD (SCORE)	CINEBENCH 20 - SINGLE THREAD (SCORE)	BLENDER 2.79 BMW RENDER - TIME (SECS) LOWER IS BETTER	7ZIP - MILLION INSTRUCTION PER SECOND	POV-RAY - RAY TRACING (PIXELS PER SECOND)	HANDBRAKE VIDEO ENCODING - FPS (HIGHER IS BETTER)
INTEL CORE I9-9900K	4,948	511	217.3	53,617	4,293	51.4
AMD RYZEN 9 3950X	9,201	526	124.0	99,450	7,893	71.1
INTEL CORE I9-10980XE	8,813	465	137.8	101,682	7,384	66.3
AMD RYZEN THREADRIPPER 3960X	13,644	516	85.6	157,027	11,207	89.9
AMD RYZEN THREADRIPPER 3990X	24,813	494	47.9	187,016	13,446	65.5

	CPU-Z - MULTI THREAD (SCORE)	CPU-Z - SINGLE THREAD (SCORE)	3DMARK TIMESPY - (SCORE)	TIME SPY EXTREME PHYSICS (SCORE)	GHOST RECON: WILDLANDS - 1080P, LOW (AVG FPS)	MIDDLE EARTH: SHADOW OF WAR - 1080P, LOWEST PRESET (AVG FPS)
INTEL CORE I9-9900K	5,581	578	13,560	5,106	204	252
AMD RYZEN 9 3950X	11,118	553	13,868	8,428	195	219
INTEL CORE I9-10980XE	10,530	553	13,600	8,649	203	216
AMD RYZEN THREADRIPPER 3960X	16,599	533	13,222	12,862	195	202
AMD RYZEN THREADRIPPER 3990X	32,909	527	11,910	13,968	174	215

much cheaper AM4 3950X or 9900K show it a clean pair of heels in workloads that aren't specifically coded to recognise, let alone take advantage of it. There are many reasons for this. When you consider that most users are using processors with four or eight threads, this isn't a surprise. It takes a lot of effort to produce a piece of software that scales to anywhere near 128 threads. The 3990X is simply way ahead of the curve. Just a year ago, a 32-core desktop CPU like the 2990WX was unprecedented. Add in other potential issues such as sub-optimal Windows thread allocation, lower boost clocks and a lack of multi-chip-module topology awareness and it's easy to reach the conclusion that the 3990X is far from a jack of all trades CPU. You can always disable a bunch of the cores with the Ryzen Master software, but doing that partly defeats the purpose of owning the 3990X in the first place.

With software that does support such a massive

"Feed the 3990X the right work and you'll be rewarded with unprecedented performance."

number of threads, the results are extraordinary. It's amazing to see the 3990X up to 3x as fast as Intel's 18-core 10980 XE and up to five times as fast as a 9900K. It's simply not a fair fight when it comes to properly supported multithreading.

The level to which Windows supports the 3990X is somewhat up in the air as we write this article. We didn't find any apparent issue, with our Windows Professional installation recognising all 128 threads as a 1P system, but then it's necessary to compare Windows results to Linux results to be sure. Linux has extensive roots in the enterprise space and has much better high core count awareness.

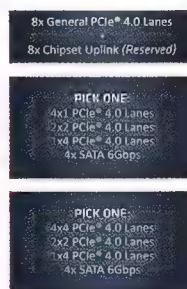
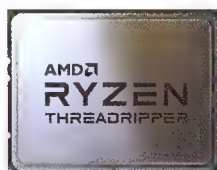
POWER AND EFFICIENCY

A 64-core processor is bound to be a difficult beast to tame. Idle temperatures in

the mid 30s and all core load in the high 70s with our 360mm NZXT Kraken X73 are pretty good, but temperatures tend to jump around quite a bit as different dies see different loads. Investing the time into an appropriate custom fan curve is advised in order to get rid of constant rises and falls in fan speed. AMD deserves credit for engineering 64 cores to run within a 280W power envelope. It also means that per-core power efficiency is simply amazing. The 3990X is also multiplier unlocked, though with the unique power demands and cooling requirements of a 64 core chip, overlocking of this CPU is really not recommended unless you have absolutely top shelf custom watercooling. If plan to OC or even simply enable PBO, be prepared to see power and temperature

levels rise dramatically.

The Threadripper 3990X is simply a monster of a CPU, but we recommend it only if you have highly parallel workloads that can make use of its power. A prosumer or ultra-enthusiast will be better served by the likes of a 3970X or 3960X. If you're a professional who renders, data mines, compiles, prototypes, encodes or runs a load of virtual machines, you'll already know if the 3990X is right for you. Time is money if you can deliver your completed project that much faster. Feed the 3990X the right work and you'll be rewarded with unprecedented performance. For the rest of us? Come back in a couple of years when the software has caught up. With 6- and 8-core processors only now going mainstream. It's going to be a long time before a 64-core processor is truly beneficial for an enthusiast, let alone the average consumer. Still, we love the 3990X and it's a technological statement par excellence. Chris Szewczyk



Verdict

Easily the most power desktop processor ever, though it's highly conditional on the workloads you feed it.





MOTHERBOARD

\$1,399 | WWW.ASUS.COM

Asus ROG Zenith II Extreme Alpha

The ultimate motherboard for the ultimate CPU.

Just a generation ago \$1,000+ motherboards were seen as lunacy, but with the utter dominance AMD currently has over the very high end market, suddenly a board like the Asus ROG Zenith II Extreme Alpha isn't so ridiculous anymore. If you're going to go down the 64-core Threadripper route then you need a serious board that's top shelf in every way. The Alpha lives up to its extreme name. It's pretty much got the best of everything. We think you'll be hard pressed to find a more capable motherboard, whether it's for an ultra-enthusiast monster system, a machine learning computational powerhouse or a multi GPU rendering mega workstation. This is a board that can do it all.

The ROG Zenith II Extreme Alpha (we'll call it the Alpha) is an updated version of the Zenith II Extreme that was released with the lower core-count TR processors. The headline difference is

the redesigned VRM system with 16 power stages each capable of delivering 90 amps of clean current. With dual 8+8+6 pin power connectors, this is a board that truly supports 64-core overclocking, and it's all cooled by an especially robust cooling system. With all the metal heatsinks all over the board, it's very heavy indeed.

We'd need to take up half of this entire issue to talk about what this board has. In short, there are 4x 16x slots and it can take up to 5x M.2 SSDs, all which are all wired with PCIe 4.0 of course. Then there's eight SATA ports, Wi-Fi 6, 10G Aquantia LAN, loads of USB 3.2 and more.

Most of the specifications from the non-Alpha have been carried over. Though some may question why Asus would include things like the OLED display or RGB on a platform that has its roots in the enterprise space.

As you can see in our

review of the 3990X in this issue, the performance on offer is nothing short of ground-breaking in applications that can make use of 128 threads. But, all this threading power leaves performance quite unbalanced. There is still some way to go before the software really catches up. We compared the Alpha to the MSI Creator TRX40 and got interesting results. There was quite a lot of variation across different multiple benchmark runs, perhaps this is another indicator that Windows needs some fine tuning to get the most out of a 128-thread processor.

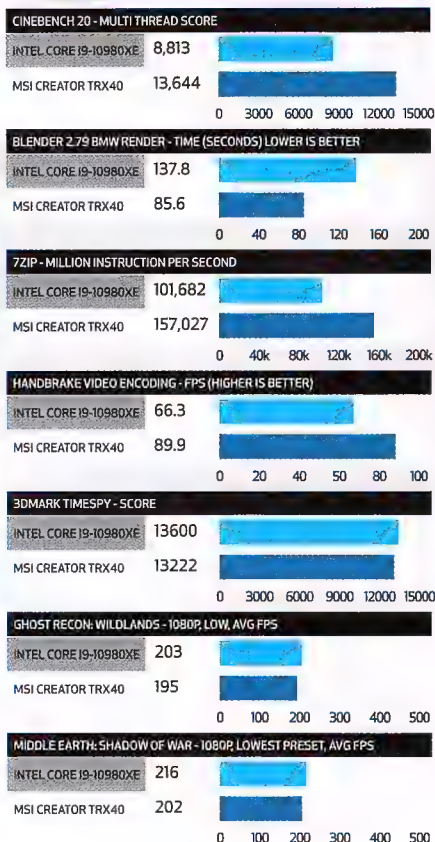
The Alpha is the ultimate motherboard for the ultimate CPU. Actually we think it might be one of those very rare PC parts that will hold a lot of its value in the years to come. TRX40 boards will always be rare, and the Alpha is amongst the rarest of the lot.

There's not really all that

much to say beyond a lot of superlatives. There just might be motherboards that match the Alpha, but it'll be tough to beat it. It's got the connectivity, expandability, refinement and customisation options and yes, the good looks that are worthy of a very high end desktop. It's a technological tour de force and it's almost like a statement from Asus: "Look at what we can do". Sure, it's total overkill and overpriced for 99.9% of users, but who cares about that when you're talking about the best. ■

Chris Szewczyk

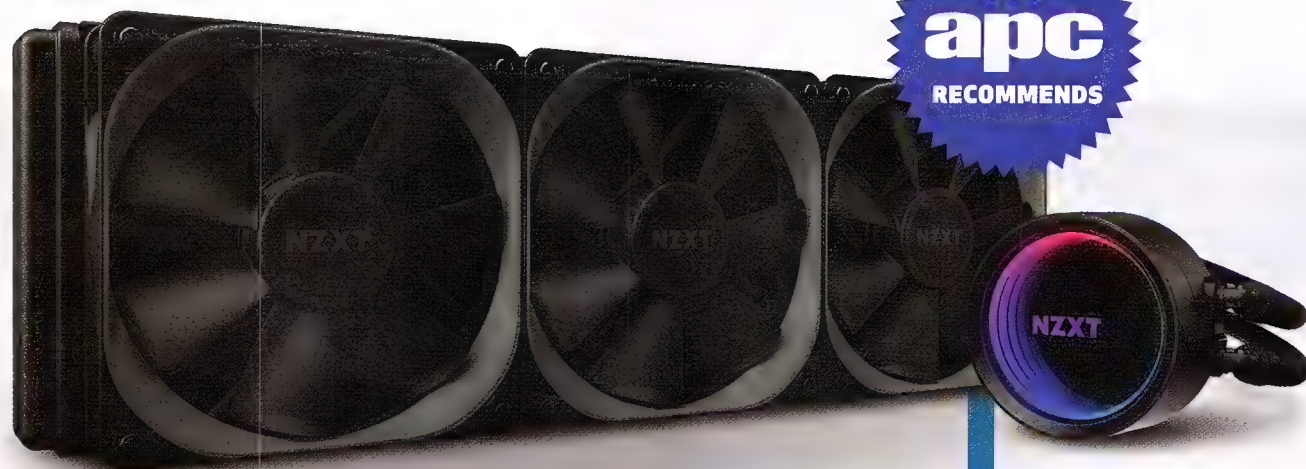
LABS BENCHMARK RESULTS



Verdict

If you're running a \$6,500 CPU, then this is the kind of equally capable board you'll want to go with it.





COOLING

\$275 | WWW.NZXT.COM

Nzxt Kraken X73 AIO Liquid Cooler

Premium tier cooling for ever hotter CPUs.

Over the years, Nzxt has earned a reputation for its high quality range of AIO cooling products. The Kraken X73 we're reviewing here is an updated version of the popular X72. New features include an improved pump and fans. The X73 is a 360mm design, however it's also available in 240mm and 280mm versions. There's also a higher end version called the Z73, which features a customisable LCD screen atop the pump. As you'd expect, the X73 is compatible with all the current (and many older) platforms, including Threadripper CPUs that ship with an included adapter that's compatible with the X73.

The X73 utilises popular Asetek components, though Nzxt added its own aesthetic and functionality touches. The tubing is 400mm long, which is a clear advantage for users

with large cases. The pump head looks fantastic with its infinity mirror RGB design. A really nice touch is the way the cap can be rotated so the Nzxt logo can be seen in the orientation that you choose. This solves the problem of having to orient a logo sideways or upside down to accommodate the requirements of your installation.

The X73 comes with three 120mm AER P120 fans. Somewhat surprisingly, they don't have any RGB lighting, though whether that's a good or a bad thing is up to your personal taste. The fans make use of fluid dynamic bearings and have a rated speed of 500 to 2,000 rpm. When under light load the fans are all but silent, and only when you push them to the maximum do they become somewhat loud. That's the way for all fans when you push them hard though, no matter how quiet they are promoted as being.

Nzxt products can be controlled via the CAM software. It can be used to control various things such as the RGB colouring, fan and pump speeds though it even has functionality related to overclocking and system monitoring. It can be a resource hog though, and unless you're using a rare Nzxt motherboard, we'd stick to the motherboard manufacturer's software suites where applicable.

As is the case with most AIOs these days, installation was easy, however the USB and SATA power leads mean you'll need to give some thought to cable routing. It's not something that lends itself to a clean build as these cables are basically impossible to hide.

We tested the X73 with an Intel i9-9900K system overclocked to 5 GHz at 1.28v with a -1 AVX offset which means temperatures can get pretty toasty when under load. A sustained full

load with a peak temperature of 79c is very good at a 25c ambient temperature.

The Nzxt X73 is definitely a top tier cooling solution, however at \$275, it's seriously pricey. Most users will be better served by an air cooler, but if you're running an overclocked 9900K or HEDT system, you'll need top notch cooling to handle it. The Nzxt X73 does it with ease, but its pricing needs to be more attractive in order to earn an unequivocal recommendation. ■

Chris Szewczyk

Verdict

The Nzxt X73 delivers excellent cooling performance but boy, does it come at a price.





FROM \$4,299 | AORUS.COM

Aorus 17

The new Aorus 17 is trying to change the framing of professional gaming laptops, by making them much faster.

Aorus is Gigabyte's premium gaming brand and the Aorus 17 is the biggest and most powerful gaming laptop the company makes. This weapon can be fitted with an Intel Core i9-9980HK CPU, 32GB of RAM and a Nvidia GeForce GTX 2080 GPU if you go all out. But even the entry level Aorus 17 XA comes with an Intel Core i7-9750H CPU, 16GB of RAM, and a GTX 2070 GPU, which is more than enough for some fast paced Full HD gaming. High refresh rate, low latency screens are starting to become more accessible, and the advantages for competitive gamers is becoming more apparent. So it is an excellent time for Aorus to have introduced a 240Hz panel to its most premium device. The 17.3-inch FHD panel from AUO is one of the fastest refresh rates available, but interestingly its response time was 3ms, a little behind the 1ms you get

from the highest performing professional gamer screens.

Both the Aorus 17 XA and the Aorus 17 YA have more than enough grunt to get games up and running fast enough to make the most of a 240Hz panel, though you are obviously likely to see a lot better results from the higher specced Aorus 17 YA. We tested the higher powered unit in this review and was able to get demanding modern games like *The Division 2* running at 91 frames per second using Full HD Ultra graphical settings. At this pace you are definitely going to see some benefits from the faster screen, but studies done by Nvidia have shown that your performance will continue to improve significantly if you push your screen to run up to (and even over) 144fps. Even with the Aorus 17 XA and its RTX 2080 GPU, you're probably going to need to compromise

on some graphical settings in order to crank the screen up over 144fps on any real looking first person shooter titles.

The Aorus 17 XA with a GTX 2070 will set you back around \$3,299, while the 2080 wielding Aorus 17 YA costs either \$4,299 or \$5,399 depending on whether you get an i7 or an i9 CPU. These premium price tags mean that these devices come with some desirable features including a full sized, Omron mechanical switch keyboard, AI hardware acceleration software and either a 512GB or a 1TB PCIe 3,000/1,500MB/s internal SSD. There's also independent Xrite Pantone certification for colour precision of Delta E less than one (which means you'll have a colour profile with extremely precise colour reproduction) and you have top of the line Killer Ethernet 2600 and Wi-Fi 6

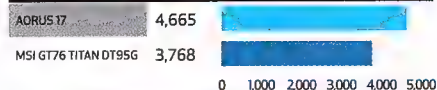
AX1650 network connectivity.

The 94Wh battery has a pretty standard 2 hours and 23 minutes battery life in PCMark Home battery benchmarks. While the i9-9980HK is a extremely powerful 2.4-5GHz CPU the Aorus 17 managed to keep it under 100 degrees at all times across our testing. The unit was outperformed by an overclocked MSI GT76 Titan, but if you wanted to tweak CPU performance you can push this chip a little further. ■

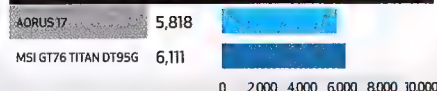
Joel Burgess

LABS BENCHMARK RESULTS

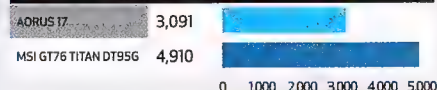
PCMARK 8 - HOME (SCORE)



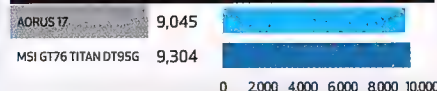
GEEKBENCH 4 - SINGLE CORE



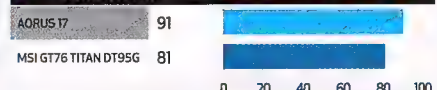
CINEBENCH R20 - MULTI-THREADED CPU



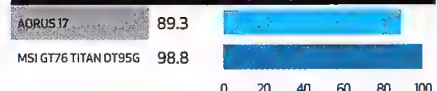
3DMARK TIME SPY (SCORE)



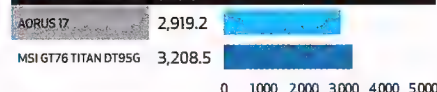
THE DIVISION 2 - ULTRA 1080P (FPS AV.)



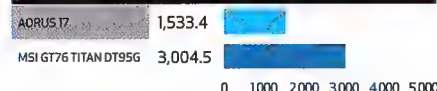
TOTAL WAR: WARHAMMER II - ULTRA 1080P (FPS AV.)



CRYSTALDISKMARK READ (MB/S)



CRYSTALDISKMARK WRITE (MB/S)



Verdict

The ultra-fast screen is a welcome addition to the most powerful 17 inch Aorus money can buy.





AUSTRALIAN PC AWARDS 2020

What was the best PC
gear of the year?

Presented and judged by *Future Publishing Australia*, for readers of *APC*, *TechLife*, *PC PowerPlay*, *TechRadar*, and *PC Gamer*, the *Australian PC Awards* recognises the best gear for PC and the companies behind the gear.

www.techradar.com/au/australian-pc-awards

The winners will be announced at a special gala event on April 2,
and published online the next day, with all the details in the
May issue of *APC*!

apc **TECHlife** **PC PowerPlay**

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FUTURE
PUBLISHING



LAPTOP

\$3,395 | HP.COM

HP Elite Dragonfly

HP's new professional ultrabook comes with a novel feature set and a lightweight chassis.

HP has designed plenty of premium work laptops, but the Elite Dragonfly is a little more professional than most. Anyone who has to work on-the-go will appreciate this device's sub-1kg overall weight and the fact that it comes with a sim-card slot for uninterrupted 4G LTE internet. It's also got all the security trimmings of a solid professional ultrabook with physical shutter camera, fingerprint sign-in sensor and a privacy screen that can't be viewed from side angles.

However, the Elite Dragonfly introduces some novel perks including Tile integration that allows you to locate your unit (even when it's off), AI-based malware detection software that'll flag suspicious activity from unidentified PC viruses, and an in-built OS recovery software that'll safeguard you from ransomware attacks.

The honed metal chassis is built from recycled magnesium and the

Dragonfly Blue finish with glossy steel trimmings make a stylish and professional looking partnership. Two buckle hinges hold a 13.3-inch Full HD or 4K screen (\$100 at some outlets) to the base and allow this convertible to fully fold back on itself. HP includes a stylus that offers enough touch sensitivity to write notes and draw convincingly using an artificial pencil or paintbrush and the backlit membrane keyboard has been designed to be as quiet as possible. The keys themselves offer enough resistance to be comfortable to type on and the trackpad is smooth and nicely sized. The keyboard surround speakers were designed by Bang & Olufsen and are loud enough to work well for both conference calls and media playback.

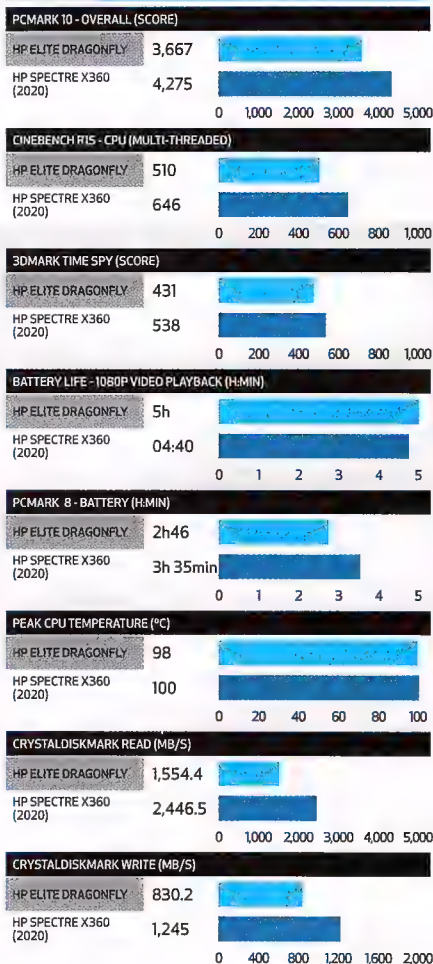
While all these trimmings are nice attributes, can it handle whatever work you need to do. These days a lot of tasks will be lightweight document processing or

browser based, but the Elite Dragonfly can be configured with four variations of 8th Gen Core i5 or Core i7 CPUs to match your workload. We tested a unit running an Intel Core i5-8365U and 16GB of RAM and while these are not the latest generation of laptop CPUs, they actually hold their own against any 10th generation chips. The Elite Dragonfly was less than 10% behind the Microsoft Surface Laptop 3 running a Core i5-1035G7 CPU and 8GB of RAM in general work tasks and it was only 14.2% behind the HP Spectre x360 we tested with a Core i7-1065G7 across the same PCMark tests. If we look at raw CPU computing tasks then the Elite Dragonfly's performance was between 20% and 33% behind these 10th generation chips in Cinebench multi-threaded tests. When it comes to graphically intensive tasks the Elite Dragonfly's performance lagged even

further, with its Intel UHD 620 GPU performing between 15% and 50% behind the new Intel Iris Plus GPUs on laptops running 10th gen chips.

The 36.8Wh battery life was disappointing, lasting 50 minutes less in PCMark 8 Home Battery benchmarks than a HP Spectre x360. The Elite Dragonfly also only managed five hours of movie playback a time, which was just 20 minutes longer than a Spectre x360 with a power hungry 4K screen. Considering you can get a much better specced Spectre x360 with a 4K screen for between \$400 and \$1,000 less, all the Elite Dragonfly's premium perks come at a cost. ■ Joel Burgess

LABS BENCHMARK RESULTS



Verdict

A premium ultrabook with a premium price tag, a slightly older processor, and a long list of professional features.





LAPTOP

\$1,699 | WWW.SAMSUNG.COM/AU

Samsung Galaxy Book S

Samsung's Galaxy Book S is thin – both in terms of form-factor and usability.

On paper, Samsung's Galaxy Book S comes across as a very attractive proposition – it's both impressively-thin (11.8mm) and ultra-lightweight (961g) for a clamshell notebook that runs Windows 10, making it seem like an ideal option for those who often take their work on the road. That said, the fact that it's powered by an ARM-based processor will undoubtedly present a number of performance and compatibility issues for those who want to do more on their machine than run productivity apps and browse the web.

From a design standpoint, there's no denying that the Galaxy Book S is gorgeous. Minimalism is the word of the day here, with the notebook's lid curving towards the hinge and sporting an anodised aluminium finish that's complemented by a small and shiny embossed Samsung logo. On the sides, it's got two USB Type-C ports (neither are

Thunderbolt, unfortunately) and a 3.5mm headphone jack, so you'll have to rely on dongles for anything else. Additionally, there's a microSD slot on the laptop's underside, giving users the option of expanding on the 256GB of storage that's already onboard.

When opened, the Galaxy Book S reveals a 1080p touch display (a surprising step down from the first Galaxy Book's 1440p screen) with minimal bezels along its top and side edges (and a significantly larger one below), along with a chiclet-style keyboard and decently-sized trackpad. The design is not without its flaws, though – the combination of a light body and stiff hinge make it extremely tricky to open the Galaxy Book S one-handed, and while the keyboard is fairly satisfying to type on, we're disappointed by its lack of backlighting. Still, we love the inclusion of a

fingerprint scanner on the keyboard's power button, with the notebook's instant-on functionality allowing for lightning-fast sign-ins.

The Galaxy Book S's sleek design is made possible by the ARM-based Snapdragon 8cx processor that powers it. While it's essentially a beefed-up mobile chipset, it's able to run Windows 10 Home in a fairly snappy manner – and with the added bonus of built-in LTE connectivity. Regrettably, that same processor is also the main source of the Galaxy Book S's shortcomings. For starters, it'll only run 32-bit applications, or those which have been ported over to ARM64. Because of this, we weren't even able to run the majority of our usual benchmark programs. Geekbench was one of the apps that did work, however. Our results were wildly inconsistent with what we've seen on a number of benchmarking websites – in our CPU

benchmark tests, the Galaxy Book S achieved single/multi core scores of 2071/6461, placing it above last year's ARM-based HP Envy but well below the likes of Microsoft's Intel Core i5-powered Surface Laptop 3. Of course, one benchmark alone hardly paints an accurate portrait of what the Galaxy Book S is capable of. More concerning is that the notebook seemed to struggle while switching between multiple Google Sheets in Chrome. Where the Galaxy Book does outclass the competition is in its battery life, providing just under 12 hours of juice in our intense battery draining test.

■ Stephen Lambrechts

Verdict

It works fine as a secondary device for lightweight tasks – just don't expect too much more from it beyond that.





"It offers AC3000 levels of bandwidth spread across three bands (two 5GHz and one 2.4GHz) to potentially provide 3,000Mbps of throughput."

ROUTER

\$209 | EN.AVM.DE/PRODUCTS/FRITZBOX

Fritz! Repeater 3000

Expensive but offers simple setup and decent performance from a reliable brand.

Fritz! is, not surprisingly, a German networking brand. It's notable for cramming as many features as possible into dated-looking devices that have unconventional design flourishes. While Asus' top routers might rival them for number of features, Fritz!'s features actually all work (usually). Their foot-in-the-past outlook also means that the company looks after its legacy products and customers and this has helped build a large, loyal, expert community that hold the brand in reverence.

A stereotypical Fritz user wouldn't dream of using auto-connect wizards, preferring to get their hands dirty under the hood. However, the Repeater 3000 may disappoint in this regard because it has one button which manages WPS connection (one second press), connects to other access points (six-seconds) or factory resets (15-seconds). Wanting to get a feel for the genuine Fritz!

experience, we went through the browser settings but found that all we could configure was language and location. After that it was simply a case of choosing which Wi-Fi network we wanted to extend and entering the password. Too easy. Literally.

Before we get onto actual performance, it's worth noting that the slightly unusual design actually makes it one of the better-looking Wi-Fi repeaters we've seen. We also liked the fact it came with a separate power cord as repeaters are often bulky with integrated plugs that impact upon neighbouring sockets.

It offers AC3000 levels of bandwidth spread across three bands (two 5GHz and one 2.4GHz) to potentially provide 3,000Mbps of throughput.

We tested it in a three-storey Sydney Town House by downloading large video files from a Synology DS1019+ NAS to a Wi-Fi-6-

equipped Dell XPS 15 OLED laptop. We pitted it against the 2.4GHz channel of our super-charged TP-Link Archer AX11000 to see how it fared against the best Wi-Fi 6 router on the market. This wasn't the fairest comparison but we're in an AX-Wi-Fi world now and we wanted to see how it compared at distance. It's notable that even though we connected to the TP-Link's 2.4GHz channel, the Repeater repeats the signal over all three of its bands and yet still only appears as part of the host network's SSID – not a separate 'Extended' network.

We tested next to the router, one floor up and two floors up. The Repeater was placed on the first floor. On its own the TP-Link transferred files at 182.5Mbps (up close), 118.3Mbps (first floor) and 79.6Mbps (second floor). When the Repeater was turned on

the first floor score was slightly slower at 110.5Mbps but the second floor score was some 20 per cent higher at 102.5Mbps.

Thus, the Repeater works particularly well at distance – dramatically so if you're boosting a Fritz! router with no Wi-Fi 6. Multiple units can also be combined to form a mesh network.

At \$209 it's expensive for non-Fritz! fans; especially in a market flooded with cheap Wi-Fi Extenders. However, if you want the reliability that's associated with Fritz! – and that's not inconsequential in the world of Wi-Fi – it's simple to use, fast and likely more stable.

■ Nick Ross

Verdict

An excellent networking solution that works better than expected over long distances.





Tenda MW5s Mesh Wi-Fi

Despite some design foibles, the MW5s Wi-Fi mesh offers easy setup, good performance, plus convenience at a low price.

Into the saturated mesh Wi-Fi market, Tenda has launched a new AC1200 system. Two questions immediately spring to mind: why should we care and who the heck is Tenda?

We'll answer the second question first because, despite reviewing Wi-Fi products since the beginning of Wi-Fi products, we had to look up who Tenda was. The Shenzhen-based company states on its website, "Founded in 1999, Tenda technology is the recognised leading supplier of networking devices and equipment. Tenda has committed to delivering easy-to-install and affordable networking solutions, offering innovative, cutting-edge products to realise people's intelligent life."

A partnership with Broadcom adds credibility to its anonymity outside of China, but what makes this kit interesting is that it's ranged by OfficeWorks. Enthusiast consumers might

roll their eyes, but many workers will know that, when you absolutely need something (potentially) business related, OfficeWorks can be convenient to the point of feeling like a life saver. A three-node kit costs \$179 (two-nodes are \$129) which is relatively cheap. But is it any good?

Set-up is simple: you plug in the primary node and connect to it, via a QR code, on the partner smartphone app. You don't even have to add extra nodes via the app, you simply power them on and the system does the rest. Just note that there are only subtle visual differences between the primary node and two secondary nodes so keep the instructions handy in case someone needs to set the system up again down the line.

Each node has two ethernet ports though only the primary node offers Gigabit speeds. Features include Guest Network and Parental Controls which

allow you to select if-and-when individual devices can access the internet. There's UPnP and (unusually for mesh devices) Port Forwarding while QoS functions prioritise Gaming and, er, web browsing. It offers a theoretical bandwidth of 1,200Mbps spread across 5GHz and 2.4GHz bands. But how does it perform in the real world?

We tested it in a three-storey Sydney Town House by downloading large video files from a Synology DS1019+ NAS to a Wi-Fi-6-equipped Dell XPS 15 OLED laptop. We did this near the nodes, at close range, one floor up and two floors up – all while simultaneously streaming a 4K movie to a TV plus YouTube videos to two, old, Android tablets. We compared results with our similarly-specified, three-year-old, Google Wi-Fi mesh.

Up close, Google pulled ahead with speeds of 178.5Mbps compared to 131.3Mbps. However, once we started climbing stairs,

Tenda took over. One floor up it scored 119.7Mbps compared to Google's 50.9Mbps while two floors up the scores were 81.3Mbps (Tenda) and 43.7Mbps (Google).

The superior performance at range makes the Tenda a clear winner. We still prefer TP-Link's Archer AX6000 Wi-Fi 6 router due to it being a singular entity with superior range, speed and future-proofing but, at \$400, it's more-than double the price. As such, the Tenda represents great value, decent performance and, if you live near an OfficeWorks, you can pick one up immediately without waiting days for delivery.

■ Nick Ross

Verdict

A very good value proposition, delivering good networking performance for the home.





MONITOR

\$1,999 | WWW.BENQ.COM

BenQ DesignVue PD3220U

Made for Mac, nearly perfect for PC.

Shop carefully and you can pick up a 4K monitor for under \$400; \$600 will bag you a 32-inch 4K monitor with a decent VA panel. Which begs the question: Why would you unload nearly \$1,200 on this?

It has a 31.5-inch panel, 4K resolution, and tops out at 60Hz. However, the DesignVue PD3220U ups the ante with IPS rather than VA panel tech. That implies better color accuracy, viewing angles, and response, but inferior contrast compared to a VA.

Problem is, \$1,200 will buy you a 4K 32-incher with an IPS panel. As it happens, BenQ itself will sell you such a screen. So, what justifies the price premium? It's not high refresh, that's for sure, what with the PD3220U pegged at 60Hz. Nor is gaming generally the remit here, even though this monitor will turn its hand to more frivolous pursuits if you have the requisite beefy GPU to drive it.

Instead, productivity and style are the recipe here. The latter involves

symmetrically slim bezels on all four sides, plus a slick stand in what Apple, were it the manufacturer, would doubtless denote as Space Gray, and which offers a full range of articulation, including rotation to portrait mode. Indeed, Apple's MacBook Pros are a large chunk of the stated target market for the PD3220U, hence the styling.

The Apple-centric execution is more than just skin deep – BenQ has also fitted the PD3220U with dual MacBook-friendly Thunderbolt 3 ports. Both allow for single-cable connectivity carrying the display signal, USB connectivity, and charging, although one port supports 85W of charging power, the other just 15W. Anyway, the point is that this is an ideal display for a single-cable setup using a powerful laptop computer, be it an Apple or a PC.

It's also worth noting that the full Thunderbolt 3, as opposed to merely USB Type-C, spec of those dual ports means you can

daisy-chain a secondary monitor and thus drive two displays with a single cable. Nifty. While we're on the subject of connectivity, a KVM switch and a hotkey puck for quick switching between display modes add yet another layer of utility to what was already a very flexible display.

Rounding out the significant specs is support for HDR10 content. BenQ is careful to not claim full HDR display capability, which is welcome, given this monitor is limited to 300cd/m² brightness and does not offer local dimming. However, the HDR10 signal processing means that colors can be seen correctly, allowing this monitor to be used for HDR content creation, a significant boon for content pros, who'll also be interested to learn that the PD3220U is claimed to be good for 100 percent of the sRGB color space and 95 percent of DCI-P3.

Bearing all of that in mind, in action, the PD3220U is as good as you'd hope. The colors and clarity are

fabulous, and the viewing angles utterly impeccable. Moreover, 4K at 32 inches provides a very nice compromise between a tight pixel pitch and usability at 100 percent scaling, if the latter is a preference. This is an impressively precise display solution.

The BenQ PD3220U is therefore a very slick all-around option for content professionals or serious desktop PC enthusiasts. In fact, pretty much anyone other than gamers would be very happy to have it as a primary display. Whether it's worth the extra money over a less well-featured 32-inch 4K IPS monitor really depends on the premium you place on flexibility and connectivity.

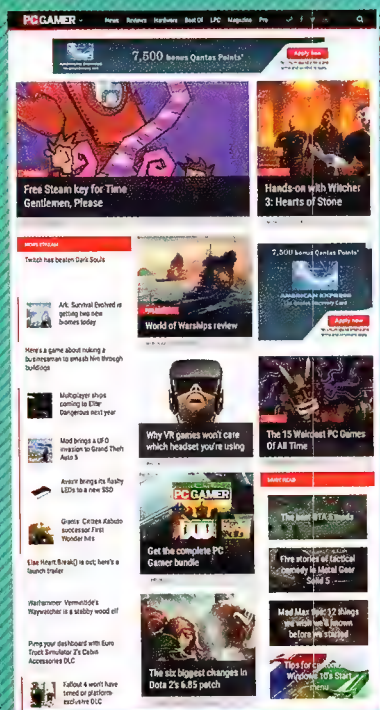
■ Jeremy Laird

Verdict

Fabulous IPS panel; fantastic connectivity but only 60Hz refresh.



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WWW.PCGAMER.COM



USB DAC

\$199 | CREATIVE.COM

Creative Sound Blaster X3

The Creative Sound Blaster X3 tries to tackle multiple audio concerns at the same time.

Chances are, your Windows PC or Mac speakers come with middling, if not terrible audio quality. Or maybe they're decent, but not quite good enough to truly enjoy what the music or games you spend time listening to.

Cue the Creative Sound Blaster X3, a USB DAC (digital-to-analog converter) with a headphone amplifier that can produce virtual 7.1 surround sound, and offers a variety of ways to enhance the audio coming out of your computer or game console.

It's like an external sound card that's compatible with PS4, PC and Mac and has the added bonus of harbouring SXFI, Creative's audio technology that simulates 3D sound in a pair of stereo headphones.

Creative found a way to keep things simple, yet provide different avenues to pursue all at once. The primary input is the large knob in the middle that controls a couple of different things, depending on setup. The three buttons laid out in

"It's like an external sound card that's compatible with PS4, PC and Mac and has the added bonus of harbouring SXFI."

front of it mute the microphone, change audio modes and toggle Super X-Fi on or off.

On the rear, there are no less than seven ports. USB-C is the power port, whereas the rest are all about audio variety. The Toslink optical output is there if you want to set up your TV or game console that way. A 3.5mm line-in port is perhaps the easiest and most common of them all. Then you have four line-outs for sound systems.

We didn't find the Sound Blaster X3 difficult to set up, though we should also note that there are several different configurations and settings to note. You also need Creative's Sound Blaster Command app on iOS or Android to help facilitate some of the features,

especially Super X-Fi. For example, if you've never used Super X-Fi before, you would need to download that app to map your face and ears and create a personalized audio profile. If you already have a profile, it's easy to link it to the Sound Blaster Command app, which then applies it to the X3.

From an audio perspective, the X3 can handle up to 32-bit at 192KHz, putting it above just about any pair of headphones you probably own (audiophile gear, notwithstanding). The amplifier inside is a nod to more discerning audio listeners, where Creative says the DAC and Super X-Fi are able to push out great sound to them.

We like Super X-Fi for the simple reason that it makes

audio sound like nothing else does. Everything resonates and the wider soundstage is easy to appreciate. Sure, there is extra reverb that does sometimes make a studio track sound like it's live, but we dig it anyway. Mind you, that's not necessarily Creative's intention. They want to emulate what a room sounds like, not a concert hall, and in that regard, we would say that results are entirely subjective. ■ Ted Kritsonis

Verdict

A bevy of different sound options worth listening to if you're tired of bad-sounding computer speakers.





GAMING HEADPHONES

\$549 | ASUS.COM/AU

Asus Theta Electret

Rare innovation in this area – but is it worth the price?

It's exceedingly rare that any company actually innovates and delivers a gaming headset that is genuinely interesting. Audeze shook things up a year ago with its planar-powered Mobius, which HyperX then cloned under license as the Cloud Obit. Adata innovated just recently with its hybrid electrostatic plus traditional speaker XPG Precogs. And Asus has just become the third company to ever release gaming headphones that actually advance things, with its new and very premium Theta Electret.

Electret drivers are somewhat similar to planar and are closely related to electrostatic drivers – in that the sound is generated by a single electrically-charged sheet of material. Unlike electrostatic, electret do not require an external power source. But you will need a good audio source/DAC to power these effectively. While the impedance is very low at 32ohm, so almost anything can drive them, you want a decent output voltage (Vrms)

"It's able to deliver a discernibly crisper and cleaner sound without distortion."

to get the electret driver working optimally. Usually a laptop, phone or motherboard delivers around 1vrms. Asus recommends at least 3vrms – preferably higher. An amp is highly recommended.

The electret driver is paired with a regular 45mm neodymium driver which covers 20-7500Hz, with the electret covering the high end of 7500Hz and above. While there's some overlap where both drivers are working in conjunction at certain frequencies, for the most part each driver is tuned to handle only its optimum range.

The nature of the dual driver type design suits gaming perfectly. Because the electret driver delivers all of the high end, and its sound signature is so distinctively different to regular speaker drivers, the treble is isolated and exists

apart from the overall noise in the soundscape. Bullets will snap and ping with sharper presence, and really stand out from the background and ambient noises. Driving games are wonderful. A high-revving engine is clearly painted as a particular sound source, with its own elevated place in the spectrum against the rumble of road noise.

This is all taking advantage of the unique attributes of the electret driver. It's able to deliver a discernibly crisper and cleaner sound, and can handle very high volumes without becoming distorted. But, it's poor at lower frequencies – hence the pairing with what Asus term the 'bass driver'.

These are pure headphones. There's no DAC built in, and it connects via 3.5mm aux with no USB option. The only control on it

is a mic mute switch. There is no RGB! But, they are indeed gaming cans, and they aren't suitable for anything else. Music falls down because the two driver types are so different the soundstage is jarringly unbalanced.

The cable is only 1.2m long, probably because it's made from expensive-sounding silver-plated pure copper.

If you really appreciate high quality audio and run an amp or headphone amp, then the Asus Theta Electret headphones are a very satisfying investment.

■ Ben Mansill

Verdict

As good as the planar Audeze Mobius; amazing for gaming, but no good for music.



software

» APPS FOR ALL YOUR PLATFORMS



Windows SOFTWARE

Balabolka

The best of the free apps.

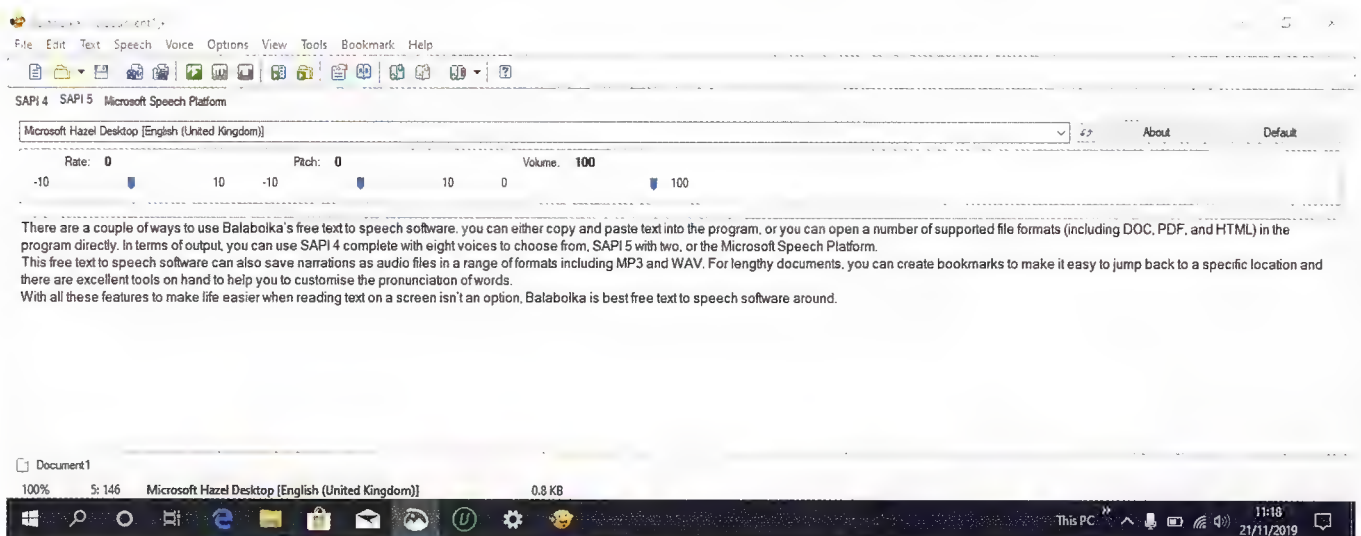
FREE | WWW.CROSS-PLUS-A.COM/BALABOLKA

There are a couple of ways to use Balabolka's free text to speech software: you can either copy and paste text into the program, or you can open a number of supported file formats (including DOC, PDF, and HTML) in the program directly. In terms of output, you can use SAPI 4 complete with eight voices to choose from, SAPI 5 with two, or the Microsoft Speech Platform.

This free text to speech software can also save narrations

as audio files in a range of formats including MP3 and WAV. For lengthy documents, you can create bookmarks to make it easy to jump back to a specific location and there are excellent tools on hand to help you to customise the pronunciation of words.

With all these features to make life easier when reading text on a screen isn't an option, Balabolka is the best free text to speech software around.



Natural Reader

Easy to use, with many features.

FREE | WWW.NATURALREADERS.COM/ONLINE

Natural Reader is a free text to speech tool that can be used in a couple of ways.

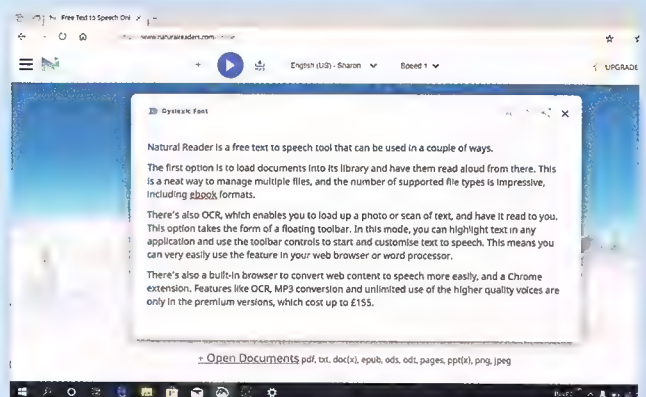
The first option is to load documents into its library and have them read aloud from there. This is a neat way to manage multiple files, and the number of supported file types is impressive, including ebook formats.

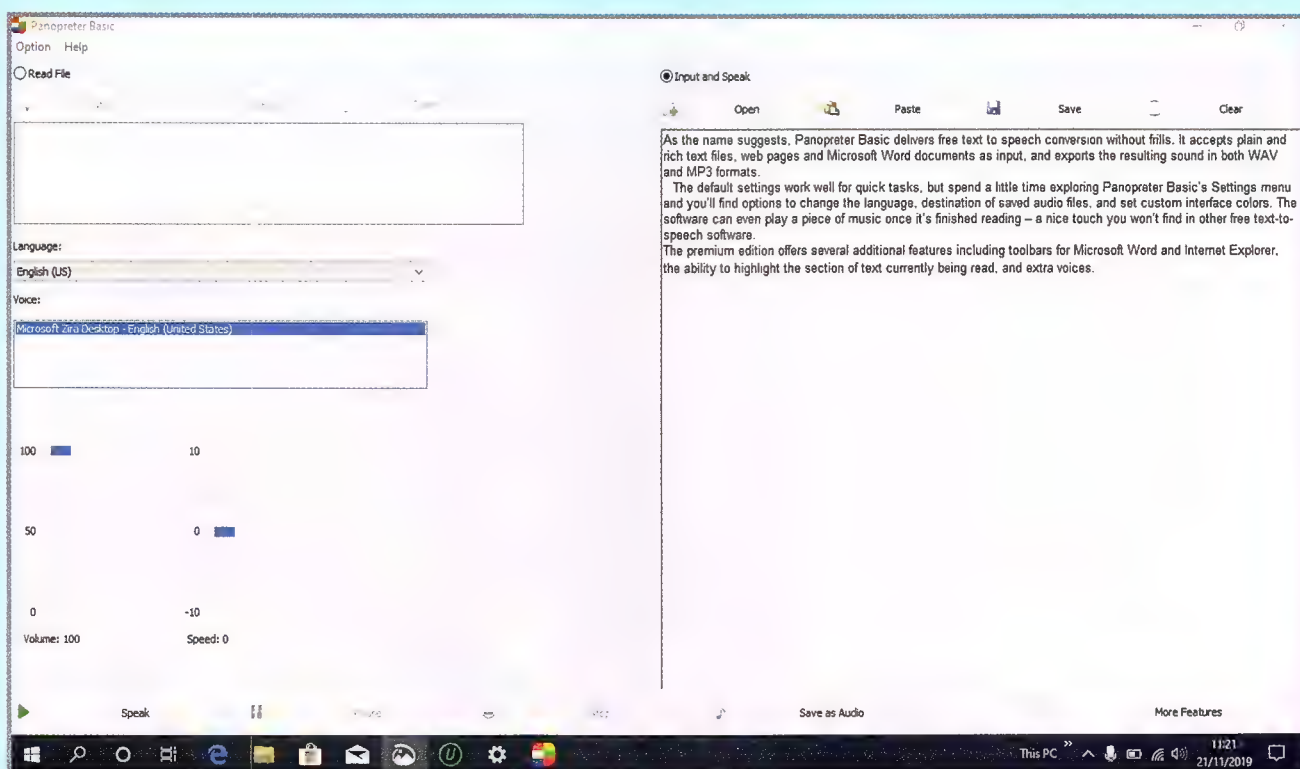
There's also OCR, which enables you to load up a photo or scan of text, and have it read to you. This option takes the form of a floating toolbar. In this mode, you can highlight text in any application

and use the toolbar controls to start and customise text to speech. This means you can very easily use the feature in your web browser or word processor.

There's also a built-in browser to convert web content to speech more easily, and a Chrome extension. Features like OCR, MP3 conversion and unlimited use of the higher

quality voices are only in the premium versions, which cost US\$9.99/month.





Panopreter Basic

Basic, yet with many good options.

FREE | WWW.PANOPRETER.COM

As the name suggests, Panopreter Basic delivers free text to speech conversion without frills. It accepts plain and rich text files, web pages and Microsoft Word documents as input, and exports the resulting sound in both WAV and MP3 formats.

The default settings work well for quick tasks, but spend a little time exploring Panopreter Basic's Settings menu and you'll find options to change the language, destination of saved audio files, and set custom interface colors. The software

can even play a piece of music once it's finished reading – a nice touch you won't find in other free text-to-speech software.

The premium edition offers several additional features including toolbars for Microsoft Word and Internet Explorer, the ability to highlight the section of text currently being read, and extra voices.

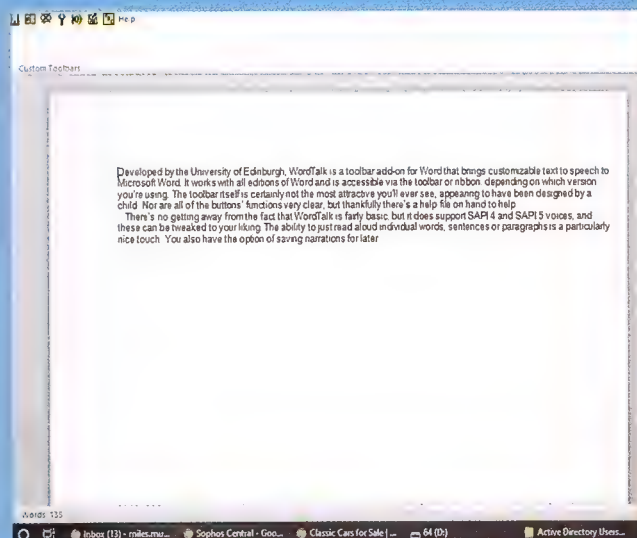
WordTalk

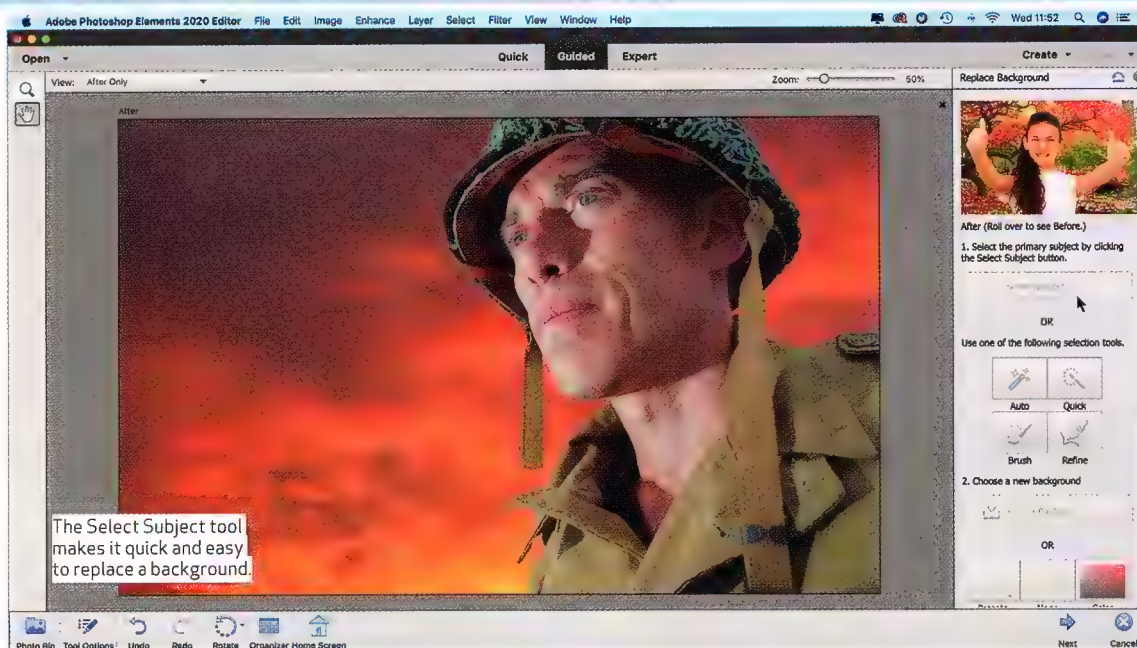
For simple needs...

FREE | WWW.WORDTALK.ORG.UK/HOME

Developed by the University of Edinburgh, WordTalk is a toolbar add-on for Word that brings customisable text to speech to Microsoft Word. It works with all editions of Word and is accessible via the toolbar or ribbon, depending on which version you're using. The toolbar itself is certainly not the most attractive you'll ever see, appearing to have been designed by a child. Nor are all of the buttons' functions very clear, but thankfully there's a help file on hand to help.

There's no getting away from the fact that WordTalk is fairly basic, but it does support SAPI 4 and SAPI 5 voices, and these can be tweaked to your liking. The ability to just read aloud individual words, sentences or paragraphs is a particularly nice touch. You also have the option of saving narrations for later.





Photoshop Elements 2020

Organise, enhance and share your shots more quickly with help from AI tools.

\$145.19 | [ADOBE.COM/AU](https://adobe.com/au) | NEEDS MACOS 10.13 OR LATER

Although Photoshop Elements is considered a cut-down version of Photoshop CC, it is perfect for your creative photo-editing needs. With the release of Photoshop Elements 2020, Adobe continues to cater for our need to edit and share shots quickly and with the minimum of effort. For example, the home screen's new Auto Creations feature applies a range of creative effects to a selection of shots. Some of the Auto Creation effects are fairly cheesy, like a background filled with star shapes.

A more useful and attractive auto effect is a background blur which simulates the shallow depth of field effect produced by DSLR cameras. This post-production blur is similar to that produced by the Portrait mode in high end iPhone models. You can leave the home screen's automatically applied effects just as they are or manually fine-tune them in the Elements Editor to create something more personal and effective.

One of Elements 2020's hyped new features is one-click selection. Instead of scribbling the Quick Selection brush over a person to select them, you can now choose Select > Subject from the main menu. Photoshop Elements uses

Adobe Sensei AI technology to analyse the shot for the most prominent subject, which it then automatically selects with a marquee. It does a reasonable job of selecting a single person or even a family group, but if there's a larger, more scattered crowd then you'll get a message saying that it can't find a prominent subject to select. You can also access a one-click Select Subject button when using the Replace Background Guided Edit.

As well as the 'Add to' and 'Subtract from' selection brush options, there's a useful new Push Selection icon that helps you reposition and soften the selection around the edges of your subject. You can then import a new background and click a button to make the isolated subject's colours and tones match those in the background to create a more convincing composite.

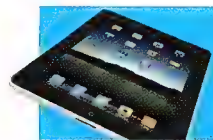
Removing unwanted people from a photo's background is something most of us will need to do at some stage, so it's good to see that the Guided Edit workspace now boasts a new Object Removal guide. By simply drawing a box around a person photo-bombing your holiday snap, the Auto Select tool does an effective job of selecting their outline. You can then click the Remove

Object button to fill the section with adjacent pixels that hide the subject. This auto-selected patch of pixels doesn't always work perfectly, but you can use Clone Stamp or Spot Healing brush to tidy up the initial AI edit. It's also a useful tool for quickly removing ugly bits of street furniture such as street lights or dangling power cables.

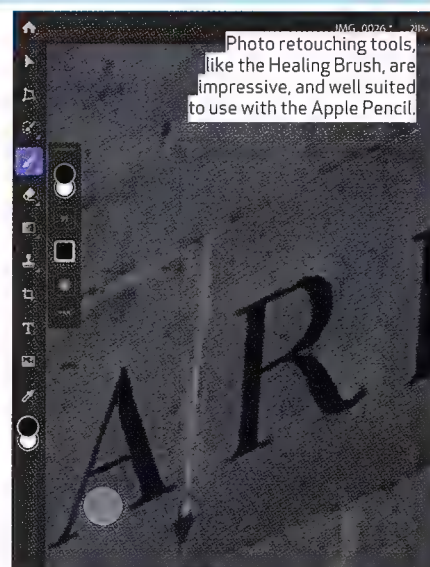
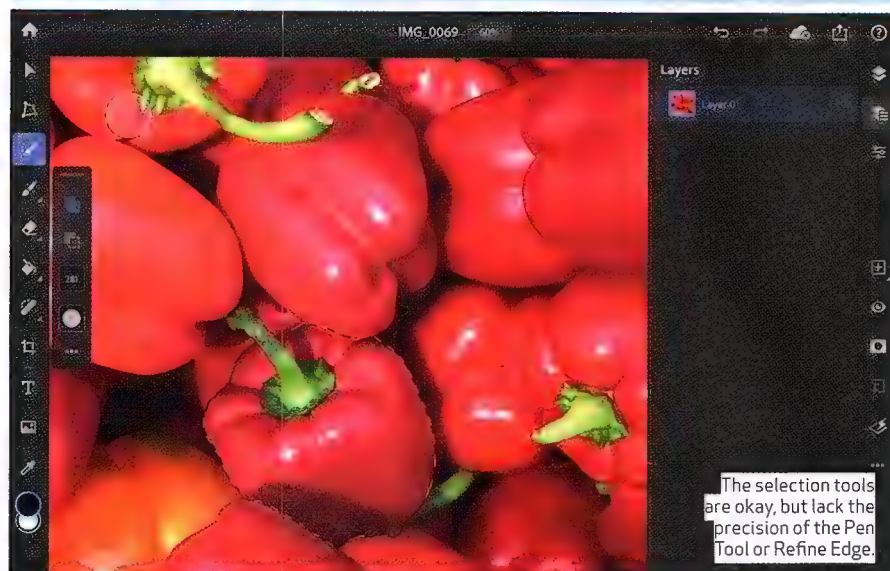
Given the popularity of posting portraits online there's a useful new tool to help flatter your subject. The Enhance > Smooth Skin command reduces the appearance of blemishes and wrinkles without the need to retouch the shot manually. It manages to blur the skin without altering key features such as the eyes or mouth. You can use a slider to dial down the skin-softening effect for a more natural look.

You can also give old black and white photos a new lease of life thanks to the clever Enhance > Colorise Photo command. After the AI operation has decided what colours to add, you can use a new Droplet tool to manually fine-tune specific areas in the colourised version of the shot. ■

George Cairns



App Store » iOS APPS



Adobe Photoshop on iPad

Does it live up to the hype of its desktop heritage?

\$29.99 PER MONTH | ADOBE.COM | NEEDS IPADOS

The wait is over – Photoshop on iPad is finally here – at least in name. Even by Adobe's own admission, this app has been released with limited capabilities, with the intention of adding more features. So does Photoshop on iPad come close to its desktop counterpart?

The opening screen of Photoshop on iPad is encouragingly similar to the desktop app, but there are notable omissions in the New Document window – no CMYK option, no link to Adobe Stock, no Artboards, no saved presets and no Advanced options. Despite the tab for 'Film and Video' documents, there is no actual video or GIF capability at this time.

Photos can be imported from your Camera Roll or directly from the Camera, while PSD projects can be continued directly from the Mac, thanks to cloud-based saving. Working offline is no problem and files are re-synced over CC when back online.

On opening a document, you're presented with a pared-back interface, with tools hidden behind a veil of icons and menus. Some icons are immediately obvious, others require some trial and error. Adobe have attempted to maximise canvas size without compromising usability. For a seasoned desktop user it takes time to reverse years of muscle memory and

adapt to new processes. There is minimal customisation here and no way to save personal presets.

The Layers tab has two configurations – a panel of small squares that take up little space and a more extensive window. Both offer basic options like Opacity, Blend Modes, Masks and Groups, but not necessarily where you'd expect to find them. It is frustratingly difficult to achieve basic operations, like grouping layers. Adding an Adjustment layer requires you to hold down the New Layer icon, select 'adjustment layer' and choose the one you want, which feels slow and cumbersome. It does however have all the vital adjustments needed for photo correction – Brightness/Contrast, Levels, Colour Balance, Black and white, Exposure and Hue/Saturation. There are currently only two Photoshop filters available – Gaussian Blur and Invert.

The toolbar is located on the left, with a modest array of tools bearing recognisable icons. The image enhancement options are fairly comprehensive, certainly among the best for iPad. The Clone Stamp, Brushes, and Healing Brush in particular, are well suited to Apple Pencil, while Transform lets you resize and distort layers easily. Without a Pen

Tool or a Refine Edge there is a distinct lack of precision. There is also a basic text option with the Type tool, but it suffers from the Character and Paragraph windows being combined into one diluted tab.

If you own an iPad-friendly keyboard then standard Photoshop shortcuts are possible, as well as useful touchscreen gestures like a double-finger tap to Undo. The most novel of these is the Touch shortcut, letting you switch between different tools without having to go back to the toolbar.

There are instances where certain gestures would feel logical, such as double-tapping the screen to confirm a transform, but the app doesn't quite work that way. Perhaps indicative of Adobe's commitment to an evolving system that responds to feedback...

At Adobe Max 2018, Adobe described this app as "not a watered-down version of Photoshop, this is real Photoshop". Unfortunately, it's more like a pick-and-mix of popular features, focusing on retouching and compositing – Photoshop with stabilisers on. As a basic portable photo editor it certainly ranks among the best, but there are plenty of apps that do a similar job at a cheaper price.

Matt Smith



Endless OS 3.7.4

A 15GB ISO for a distro designed for areas with poor connectivity sounds oxymoronic, but that was just Mayank Sharma being short-sighted.

FREE | WWW.ENDLESSOS.COM

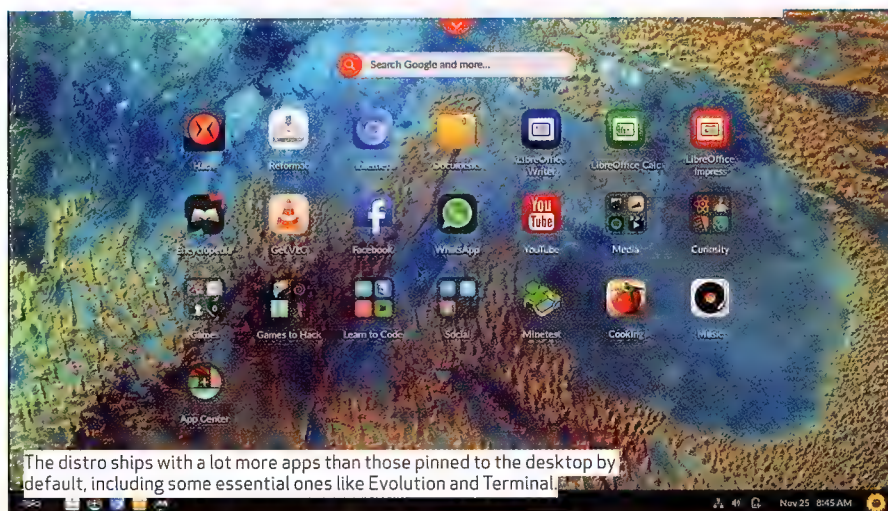
The first thing that strikes you about Endless OS (besides the humongous size of its ISO) is that it doesn't resemble any desktop environment. To call it a customised Gnome desktop is doing a disservice to the Endless developers. It's not like some other desktops that use an extension or two. Dubbed the EOS Shell, Endless's desktop is a complete departure from the typical Gnome 3 interface. For starter's there's no application launcher menu; you get application icons and groups on the desktop. There's also a global search bar at the top that you can use to hunt applications or search for the entered text on the web. At the bottom you get the traditional panel that's got a few system icons for the sound, network and power management, as well as a couple of quick-launch icons.

Endless is available in two flavours. As well as the 15GB Full edition, there is also a Basic release that weighs in at a far more manageable 2GB. Like its contemporaries, the distro boots into a live installable environment. Endless uses a custom installer that's designed to take over the entire disk, which makes it all pretty simple to operate. You don't even get to choose a custom layout or a partitioning scheme.

The installer is just one of its departures from convention in the effort to make Endless a bit more suitable for non-technical users. Another striking difference that sets Endless apart from a more typical distro is the pre-cooked locked-down environment. There's not much else to do besides clicking on an app icon on the desktop to launch it. Even the Gnome System Settings panel is tucked away under the user's icon in the bottom right corner of the desktop.

ONE WITH EVERYTHING

Just because the ISO is 15GB doesn't mean the distro is chock-full of apps. Sure, it has all the usual productivity ones, but the majority of the space is commandeered by education content



The distro ships with a lot more apps than those pinned to the desktop by default, including some essential ones like Evolution and Terminal.

"There's all sorts of content on maths, animals, physics, biology and more."

that's included in the form of apps, documentation, and even games. Besides an encyclopedia app (which is basically an offline version of Wikipedia), you'll get learning materials neatly categorised by field and subject. For instance, there's all sorts of content on maths, animals, physics, biology and more as well as HTML and CSS tutorials, and Raspberry Pi and Arduino projects.

Besides apps, several icons on the desktop are wrappers for online apps such as YouTube, Gmail, Duolingo, Twitter, and more. It goes without saying that you'll need an active connection to the internet to access these wrapped online apps. In addition to these two types of icon, the desktop also lists a few to help you quickly fetch some popular apps from the App Store, such as VLC, Skype and Spotify. Talking of music, the distro ships with 79 CC-licensed tracks from different genres totalling over five hours of audio.

Another factor that sets the distro apart from its peers is its package management system. Endless uses the Gnome Software app to help you flesh out your installation. But instead of relying on DEBs (being based on Debian), it only allows you to install flatpaks via the FlatHub repository. It complements its use of flatpaks by using the OSTree update mechanism to perform atomic upgrades that's also used by CentOS Atomic.

Despite its size, the distro didn't feel lethargic on any of our test machines, which were i3s and i5s with 4-12GB of RAM. It does include some documentation, but really the developers have done a good job to make it fairly intuitive for anyone who's ever operated a computer. If you are out looking for a distro for educational purposes, Endless will fit the bill to the letter ■



Google Play » ANDROID

Air Matters

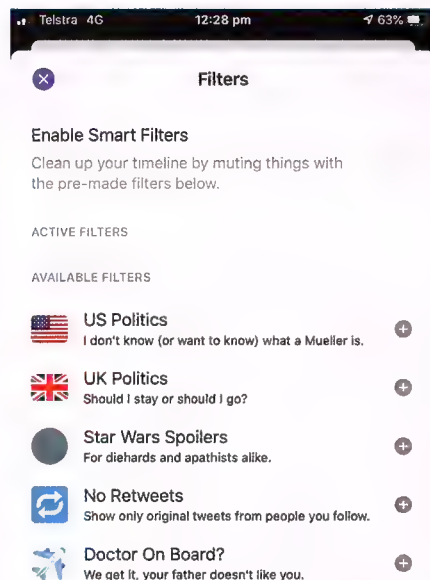
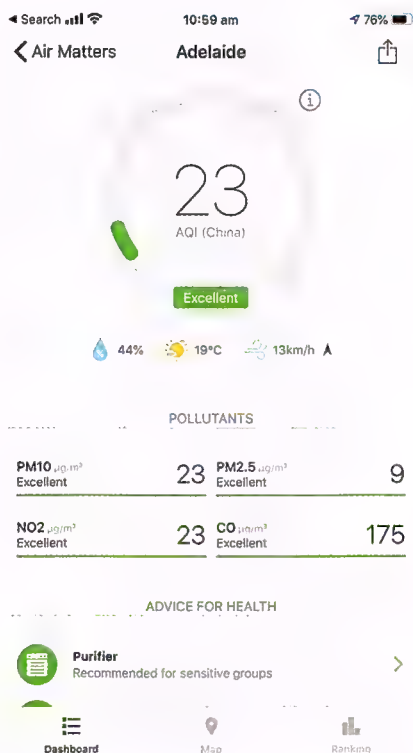
For your health.

FREE | AIR-MATTERS.COM

If you live in Australia in 2020, it's suddenly become very important to have an app that lets you know how breathable the air outside is. I know, right?

Technology has, of course, contributed to the world we're now all living in, for both better and worse, but at least with an app like Air Matters we can keep on top of what we need to do to protect ourselves, especially as there have been several days in major cities lately where leaving the house without a mask has not been advised.

I tested out a few different apps, and Air Matters was the one that most clearly communicated exactly what I needed to know. It gives you the numbers and figures you'd expect, but also makes very direct recommendations on whether you should leave the house, whether an air purifier might be a good idea, and what sort of ventilation is recommended. It provides extensive data history and charts your surrounding areas easily. Grab it now and hope you won't need it for a while. **James O'Connor**



Nighthawk for Twitter

Hawks can't fly at night.

\$5.99 | N/A

Twitter is important, but not very good, and is at least partly responsible for the terrible shape of the world. Nighthawk poses an important question – what if Twitter was, for some reason, worse?

Nighthawk's big thing is that it allows you to filter out certain topics, but, weirdly, the list of filters is extremely short and specific right now. Is it worth paying \$5.99 for a version of Twitter that does not let you track threads or add images to your tweets if, in exchange, you can disable all mentions of US politics, Star Wars spoilers, and, uh, jokes about doctors being on planes? Is it comforting knowing that you can cut out all retweets from your feed, but also won't be able to access your DMs? Nighthawk for Twitter is an extremely limited app, one that charges you \$6 for a less convenient experience. You can also add a 'Close Friends' feed, which is theoretically a nice idea – but then, that's what Twitter's in-built "list" function is for. There's no benefit to using Nighthawk for your tweeting. **James O'Connor**

AI Dungeon

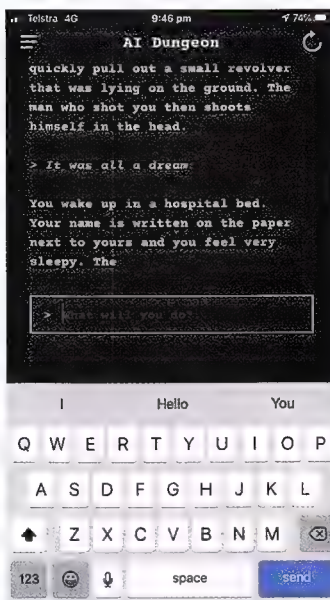
Type command 'review app'.

FREE | WWW.AIDUNGEON.IO/START

While AI Dungeon markets itself as a "game," I think it belongs on these pages – it's a narrative generator, and it's going to appeal to audiences who avoid the "game" tab on the App Store.

In AI Dungeon, you're dropped into an AI-generated narrative after a few prompts and left to work your way through it, resolve it, or see it through. AI-generated text appears, and you can give simple commands or dialog to drive it forward. I started up a detective story and after being shot decided to declare that it had all been a dream – which, shockingly, the story went along with, and things continued in the waking world.

While it often feels like the stories are trying to bend back to normalcy when you try to drive them too far off the rails, it's still fascinating how genuinely reactive the system feels to your words choices. AI Dungeon is a lot of fun to mess around with – you're not going to tell the next iconic story, but you might find yourself surprisingly engaged. **James O'Connor**



2020 VISION



What's hot and what's not in screen tech in 2020? Jeremy Laird takes a deep dive into the PC monitor market.



This Samsung C49HG90 uses quantum dot technology, enabling HDR thanks to a combination of QLEDs and a VA panel.

Screens today offer more innovation, wider choice, and better value than ever. But, by some metrics, PC displays are disappointing. By other measures, though, marketing madness is starting to take hold.

How so? On the one hand, you can now choose from a huge array of form factors, sizes, and aspect ratios, many of which are more affordable than ever. Innovations such as high refresh rates and adaptive sync have entered the mainstream. Support for HDR or high dynamic range content is becoming widespread, too. Connectivity solutions such as USB Type-C make it simpler than ever to

hook up displays to PCs of all kinds. And panel tech is improving, with better contrast, lower response times, and technologies such as local dimming contributing to dramatic improvements in image quality.

On the other hand, some elements of screen tech refuse to move forward. The most obvious involves pixel density, an issue that's related to screen resolution. But outright screen resolution is also stuck, with few monitors breaching the 4K barrier.

Even where there has been progress, the benefits are not always clear cut. Significant confusion surrounds the implementation of HDR support in PC monitors, for instance. That's the polite

way of describing a huge amount of HDR marketing FUD (fear, uncertainty, and doubt). Likewise, refresh rates continue to escalate despite diminishing returns. And the price of USB Type-C connectivity remains painfully high.

In hindsight, it's also disappointing that LCD technology remains dominant. Five years ago, you'd have put good money on OLED achieving at least some significant penetration into the PC monitor market. Save for some limited appearances in laptop PCs, it's virtually non-existent.

If that's a helicopter view of screen tech in 2020, it's time to swoop down into the detail.



4K remains state of the art in 2020.



HP's Z38c is a stunner, but it's not high DPI.



Will Apple's 6K panel turn up in a PC screen?

If there's a single metric by which PC display technology disappoints in 2020, it has to be pixel density. A decade ago, it seemed inevitable that high-DPI displays would be the norm on the PC by now. The reality? DPI levels on most displays barely breach 100. In other words, there has been little or no change from 10 years ago.

DPI refers to dots per inch, a measure of how densely pixels are packed into a given area of screen. The denser or more numerous the pixels, the sharper and clearer the image. Fonts are particularly sensitive to pixel density, but it's important for screen clarity and image detail, period.

Take the new HP Z38c, a desirable new 38-inch ultrawide monitor, with a \$1,200 price tag. At first glance, the Z38c's native resolution of 3840x1600 pixels sounds like plenty to justify its premium positioning. But do the pixel density math, and the result is a DPI of just 109 pixels per inch. That's actually slightly worse than a bargain basement 1080p 20-inch monitor that you might pick up for \$150.

Compared to smartphones, that kind of pixel density is pathetic. Even budget smartphones typically deliver upward of 300 dpi. Of course, smartphones and PC monitors are not directly comparable. The practical impact of pixel density in terms of image quality depends upon viewing distance. The shorter the viewing distance, the more pixels are required for a given level of detail or clarity.

Obviously, phone screens held in the hand are viewed at shorter distances than PC monitors. Apple's "Retina" display standard provides a useful metric. The idea behind it is the human eye's ability to resolve individual pixels. The point at which the pixels are so small they can't be individually discerned is the point at which adding further pixels does nothing to improve sharpness and detail. You can achieve the "Retina" point by moving a display further away or by adding pixels.

Apple puts that point at around 300 dpi for smartphones and 200 dpi for desktop and laptop displays. It's not an

exact science and one can debate the distances, required DPI levels, and the acuity of the human eye. But Apple's approach provides a tolerable rule of thumb and a context in which a mere 109 dpi obviously isn't even close. That's an observation confirmed when you compare the quality of fonts on a display with a DPI of around 100 with another good for 200 dpi. The latter has much cleaner, sharper fonts.

PIXEL PORTENT

Consider the broader PC monitor market and you'll quickly find that vanishingly few products offer a true high-DPI experience. Take something like a 27-inch 4K monitor with fully 3840x2160 pixels. Impressive? Yes. But spread over that 27-inch diagonal, the result is 163 dpi. Not bad, but still well short of the Retina standard. Even a 24-inch 4K display only clocks in at 184 dpi.

What if you up the ante to 5K? LG's 5K2K monitor, the UltraWide 34WK95U, is a 34-incher and delivers 163 dpi. Speaking of LG, it also offers the 27MD5KA UltraFine, a 27-inch model with 5120x2880 pixels. Finally, we have a monitor that can top 200 dpi – the UltraFine is good for 218 dpi. Still, what that monitor shows is that you need a heck of a lot of pixels to achieve truly high DPI on larger displays.

Apple's new \$8,499 32-inch Pro Display XDR, for instance, needs a 6K resolution of 6018x3384 to achieve the same 218 dpi as the LG UltraFine. And it's not really PC-compatible. Another example is Dell's 8K monitor, the UP3218K. With 7680x4320 pixels and a 32-inch diagonal, it's good for 275 dpi. It's a proper high-DPI display, for sure, but it's very much the exception. And a \$6,000 exception at that.

Speaking of exceptions, portable PCs are the cheapest and easiest way to get a high-DPI experience. Many notebook, tablet, and convertible PCs are at least optionally available with screen DPIs of 200 or more. But unless you prefer using a laptop screen, that's not much help.

Sadly, there is little near-term

prospect of things improving. Actual LCD panels, as opposed to entire monitors, are only made by a very small number of companies. If said companies aren't offering large format high-DPI panels suitable for PC monitors, there's nothing display manufacturers can do about that. Among the big players in LCD manufacturing are LG, Samsung, and AU Optonics. As a rule, they're pretty open about their forward planning for upcoming LCD panels. For 2020, there's no sign of any new panels that will bring high DPI into the mainstream PC monitor market.

Indeed, our research couldn't uncover any new panels due out in 2020 with a resolution beyond 4K. As we've

IN SEARCH OF HDR

HDR, or high dynamic range, has always been a tricky concept, but in the recent context of PC displays, it's been more problematic than ever. What with numerous competing standards and no unifying definition of what it takes to be an HDR display, it's a minefield for buyers.

Arguably, the problem is even more fundamental than that. The ability to support or decode HDR content is one thing, the ability to render an HDR image is another. To the discredit of many monitor companies, they've conflated the two. But not all manufacturers are guilty.

By way of example, in a review of the new BenQ DesignVue PD3220U, we noted that BenQ says the display "supports HDR10 content." Arguably, BenQ could be even more explicit, but it's welcome that the company doesn't pitch the PD3220U as an HDR monitor. A quick perusal of its specs, for instance, reveals a maximum brightness of just 300cd/m². That's insufficient for true HDR visuals.



Dell's 8K panel is one of a few high-DPI ones.



2020 won't be the year of OLED PC screens.



New LG IPS panels claim 1ms response times.

seen, you need more than 4K to achieve a high-DPI experience on larger monitors. We're not even sure if the new 6K panel in the Apple Pro Display XDR will be available for other monitors. The Pro Display's panel is believed to be manufactured by LG, but it might be an Apple exclusive – at least for a time.

All of which means that 2020 won't be the year 5K, 6K, or 8K becomes more accessible on the PC. Nor will it be the year that OLED makes the jump from TV to PC. It once seemed inevitable that OLED technology would eventually take over from LCD as the default technology for PC monitors, but here we are in 2020, and OLED availability in desktop PC monitors is virtually zero.

Again, the picture is a little better in the mobile market. A number of laptops, such as Razer's Blade 15, can be had with OLED screens. But it's increasingly looking as though OLED may never become dominant for desktop monitors. Instead, the PC monitor market may largely skip OLED and jump straight to microLED.

OLED suffers from a number of problems, including burn-in and asymmetric degradation, that are particularly problematic for the PC. In terms of the former, the persistent elements of the Windows interface, such as the taskbar, make burn-in much more likely. The longer the image on an OLED display remains static, the more likely that image is to be "burned

in." The result, on a PC, would be a faint image of the taskbar permanently burned into the display.

DEGRADING EXPERIENCE

As for degradation, the first problem is that OLED light output degrades over time and with use. What's more, the individual subpixel diodes degrade at different rates. PC displays typically have pixels made of red, green, and blue subpixels. The blue diode subpixels in an OLED display degrade much faster than the red and green diodes. Without compensation, not only would your display become dimmer, but the color balance would shift as the blue diodes dimmed. Various technologies do exist to compensate for this, but PC monitors

What is sufficient? HDR10 support just indicates signal processing capability. More useful and widely applied by many manufacturers is the VESA DisplayHDR standard, which actually encompasses multiple standards. The entry-level DisplayHDR 400 certification is not, in our view, true HDR. It involves a peak brightness of 400cd/m² and only sRGB color gamut support. All the other levels of DisplayHDR certification demand at least some local dimming, which is critical for HDR for enabling the much higher contrast involved in true HDR visuals, plus a wider color gamut, and better controlled black levels. But we think it's only with DisplayHDR 1000, a standard that requires a sustained brightness of 1,000cd/m², very low black levels, and local dimming, that you get a really rich HDR experience.

Of course, all of that applies to LCD monitors; OLED is a whole different ball game and has its own HDR standards. But as we explain elsewhere, OLED isn't about to become mainstream in PC monitors.



Is BenQ's DesignVue PD3220U really an HDR display?

GET CONNECTED IN 2020

Often overlooked but ever important, the humble display interface is due an overhaul in 2020. One major development will be the roll-out of DisplayPort 2.0. It's a major upgrade versus the most recent prevailing DisplayPort standard, namely 1.4a. DisplayPort 2.0 delivers a 3x jump in raw bandwidth compared to DisplayPort 1.4a. Want hard figures? 1.4a serves up 25.92Gb/s of usable bandwidth for transporting display images; DisplayPort 2.0 ups that to 77.37Gb/s.

As for the implications of the bandwidth bump, they're numerous. The more bandwidth, the higher the resolution you can display at greater refresh, and with more dynamic range and color fidelity. For example, with DisplayPort 2.0, you'll be able to drive dual 8K monitors at 120Hz and 10 bits of color per channel over a single interface. In terms of a single panel, a 16K monitor – 15360x8640 pixels – at 60Hz will be possible. Or how about triple 10K panels at 60Hz? Another option supported by DisplayPort 2.0.

Long story short, all those high-res, high-DPI panels we're hoping for will finally be possible with DisplayPort 2.0. As for HDMI, its most advanced standard, 2.1, was announced in 2017, and no further advances have been made public. HDMI 2.1 actually compares favorably with DisplayPort 1.4a, with 42.6Gb/s of usable data. It's designed to cater for 8K resolutions with refresh rates up to 120Hz. So, it's pretty much got you covered.

Finally, there's USB Type C and Thunderbolt 3, sharing the same interface. This is a frustratingly complex subject, but the short version is that both support up to DisplayPort 1.4 in Alt Mode over the USB/Thunderbolt interface. Some examples are the Microsoft Surface Pro 7, Surface Pro X, and Surface Laptop 3, all of which support up to DisplayPort 1.4. Some even support multi-stream capability, so you can connect dual 4K 60Hz monitors via a single cable. But note: Most portable PCs made up to mid-2019 are likely to only support DisplayPort 1.2 in Alt Mode, and thus a single 4K 60Hz display.

DisplayPort 2.0 is a bandwidth bomb.

are generally more sensitive to color shifts and involve more persistent interface elements than TVs.

The alternative is microLED. For starters, it's brighter than OLED, but it's also more stable than OLED. It degrades more slowly and the rate of decay of the red, green, and blue subpixels is more even. MicroLED is also much more resistant to burn-in while simultaneously offering all the advantages of OLED, such as effectively perfect or infinite contrast and ultrawide viewing angles.

Sounds like the perfect solution for the PC, right? One day, it probably will be. For now, there are serious limitations. MicroLED is very expensive to manufacture. Current implementations are also very power-hungry. Time will tell whether OLED can solve its degradation issues before microLED gets cheaper and more efficient. Our hunch is that microLED will win out eventually.

If neither OLED nor microLED are going to be a thing anytime soon, how is display tech actually progressing in 2020? One of the most obvious elements involves refresh rates, be that the overall rate of refresh or synching that refresh with the output of the video card. High refresh beyond the industry standard of 60Hz and adaptive synching have been available for years, but the technologies are becoming more refined and more widely adopted.

One of the two competing standards in this area is AMD's FreeSync. It's been around for six years, and for 2020, AMD announced what is effectively its third major iteration. This includes two new tiers: FreeSync Premium and FreeSync Premium Pro. FreeSync Premium adds a requirement of at least 120Hz refresh support at a minimum 1080p resolution and low frame rate compensation to FreeSync's core adaptive sync capabilities. As for FreeSync Premium Pro, that adds accurate luminance and wide color gamut as part of a broader HDR certification.

Meanwhile, Nvidia's G-Sync technology has also developed into a similar multi-tier proposition, with G-Sync Ultimate topping the table with HDR requirements. Overall, there are two takeaways that apply to both. Firstly, for the most part, both are mainly of interest to gamers. High refresh is of general benefit for all kinds of computing, albeit with less impact outside of gaming, but other features, such as frame synching and ultra-low latency, really are only of interest to gamers.

The other issue to be aware of is compatibility. Previously, Nvidia was attempting to lock down G-Sync to its own video cards and displays fitted with G-Sync boards. But Nvidia has now unlocked support for FreeSync monitors with Nvidia graphics cards via the G-Sync Compatible standard. If you buy a G-Sync enabled PC monitor, though, note that you still need an Nvidia graphics card for full functionality.

TRUTH HERTZ

Speaking of refresh rates, we fear 2020 will be the year that marketing madness takes hold. The first 360Hz gaming monitors have been announced (and on show at CES). But the added benefit, even for esports addicts, of the jump from 240Hz to 360Hz is debatable at best. That would be true with a display technology fully capable of rendering 360 frames per second, but it is itself debatable whether the pixels in LCD panels respond quickly enough to make 360Hz meaningful.

That's before you ask whether you have a fast enough 3D card to play a given game at the 400fps or so average you'll realistically need to be sure the frame rate rarely dips below 360Hz. Put simply, refresh rates have the makings of a technology where more of something is assumed to be better, even well beyond the point it adds any tangible benefit.

HDR in 2020 will likewise continue to be at the mercy of marketing misinformation. You can consult the boxout below and on the following page for more detail on how to make sense of

A COLORFUL YEAR AHEAD

When it comes to HDR PC monitors, not all implementations are equal. But it's not all bad news. Even mediocre HDR brings improved color performance. Strictly speaking, high dynamic range doesn't automatically imply greater color fidelity. Instead, it's about the contrast between the brightest and darkest elements of an image.

However, in practice, HDR standards typically make requirements of a display in terms of color space coverage and color fidelity. Take VESA's DisplayHDR standard. Even lowly DisplayHDR 400 demands 95 percent coverage of the Rec.709 color space (the standard used for HDTVs), 10-bit per channel signal processing, and native 8-bit color rendering. Step up to DisplayHDR 600, and 99 percent of Rec.709 is required, plus 90 percent of the more demanding DCI-P3 color space, the standard for





Stop that, it's silly: Asus's new 360Hz gaming monitor.



Micro LED could be the next big thing, but not in 2020.

the various standards, what constitutes a true HDR monitor, and how color gamuts come into the equation. But the short version is that you want to look out for a display with local dimming and a sustained brightness of at least 600cd/m².

On that subject, as 2020 moves forward, you can expect to see displays with more local dimming zones. Early HDR monitors had 300–400 zones. The first displays with 1,000 or more zones are now appearing – Acer's Predator X32 packs 1,152.

With more zones will come better HDR visuals and fewer visual artifacts, such as light bleed or blooming around bright objects. Ultimately, only per-pixel lighting will deliver perfect HDR image quality. That isn't going to be on offer in 2020.

Another area of improvement in

2020 will be pixel response. In 2019, the first monitors with IPS panel tech and claimed 1ms response capability appeared in the form of LG's Ultragear 38GL950G and 27GL850. Those were large, premium models. By the end of 2019, AOC was offering its own more affordable 1ms IPS panel – the 24-inch Gaming 24G2U.

Of course, claimed response times are notoriously unreliable metrics of real-world pixel performance, but it's clear IPS panels are improving and the gap to the fastest TN tech is closing. That's good news if you want speediness and color accuracy in a single monitor. Even in the gaming segment, TN will be increasingly marginalized by higher quality IPS panels.

Overall, then, what will the PC monitor look like in 2020? Condensing

the key trends into a single, notional model, sadly it won't beat 4K when it comes to native resolution. Nor will it offer a true high-DPI experience. But it will have HDR capability, albeit flawed, thanks to the limitations of LCD panels, which in turn means it won't be OLED, much less microLED.

It will also offer a wider and more accurate range of colors. It'll be faster by pretty much every metric, be that pixel response or refresh rates. It'll be pretty much any size or shape you desire. Its features will play ball with both AMD and Nvidia graphics cards. And it will hook up to your PC with bandwidth to spare via a single cable providing the display signal, peripheral data, and, if you need it, charging power. The monitor of 2020 isn't quite everything we'd hoped for, then, but it's a pretty fine thing all the same. ■

professional digital cinema. DisplayHDR 600 and up monitors also need to support 10-bit color reproduction courtesy of at least dithering technology.

In short, any monitor that qualifies for at least the DisplayHDR 600 certification (there are more demanding DisplayHDR 1000 and 1400 standards) offers wide color gamut coverage. There are, of course, other standards. HDR10 is the standard created by the Consumer Technology Association. It's based around the Rec. 2020 color space used by UHD TVs, and if a display conforms with HDR10, it's in about the same ball park for image performance as a DisplayHDR 1000 screen.

The slight confusion, of course, is that a given monitor may be capable of processing HDR10 content, but not capable of rendering its full dynamic range. But a display capable of HDR10 content support but not true HDR rendering, such as the BenQ DesignVue PD3220U, will have wide color gamut coverage. In the case of the BenQ, it achieves 95 percent of the DCI-P3 gamut, which will be sufficient for all but the most demanding professionals.



Even pseudo HDR monitors have improved color coverage

superguide » wi-fi problems solved



WI-FI PROBLEMS SOLVED!

Networking issues are the pits. Nick Peers steps you through troubleshooting some of the most annoying wireless glitches.

In a world of endless wireless connectivity, it's amazing how often things don't pan out the way we expect them to. Dropped connections, weak signals and outright internet failure are just some of the problems plaguing people up and down the country (never mind all over the world).

In this feature we're going to focus on arming you with all the know-how you need to troubleshoot network and internet connections – primarily wireless, but also wired – plus examine ways in which you can improve performance and make your connection perform reliably. We'll open with a look at local connection issues – those networking problems affecting just your PC, complete with full walk-through of key troubleshooting steps to follow.

You'll also gain valuable insight into what to do if your networking problem appears to stem from your router, plus learn how to get online when your internet connection is down with the help of your phone's mobile broadband or a kind neighbour (all without compromising their network security).

We'll also look at Wi-Fi annoyances, from weak signals to network interference, revealing how to ensure the steps you take to widen your network coverage don't create more problems than they solve. You'll finish with a guide to fixing problems with file and printer sharing – whether that's simply between Windows PCs or other computers. It's all here waiting for you, turn the page to get your connection working smoothly again.

"In this feature we're going to focus on arming you with all the know-how you need to troubleshoot network and internet connections – primarily wireless, but also wired."

Page 54

Fix local connection issues

If your network problem only affects your current PC, discover the key troubleshooting steps you need to follow.

Page 56

Fix wider network faults

Nothing connecting to your network? Internet access down? Read on to discover how to troubleshoot.

Page 58

Fix niggling Wi-Fi problems

Not all issues bring your network grinding to a halt. Here's how to troubleshoot, maintain and improve your wireless performance

Page 60

Solve sharing problems

Iron out glitches with sharing files and printers with our handy fix-it guides that cover more than just Windows.

Fix local connection issues

If your network problem only affects your current PC, discover the key troubleshooting steps you need to follow.

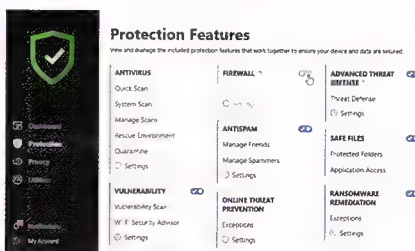
If your wider network appears to be functioning well, but the problem is isolated to a specific PC, then this section will hopefully help you track down a solution. Your first step of course is to check the physical connection itself: if you're connected via an ethernet cable, check it's securely plugged in at both ends. If you connect through a HomePlug network check the lights on the HomePlug itself – try resetting or switching the device off and on to see if it can reconnect. You may also have to do the same with the HomePlug plugged into your router, but only if the issues affect other HomePlugs and their connected devices on your network.

When it comes to Wi-Fi, check any USB adapter is firmly plugged in, and if you're a laptop user that the Wi-Fi switch hasn't inadvertently been switched off (it may be a physical switch or a keyboard shortcut involving the Fn key – look for the Wi-Fi icon above a key on the top row). You may also be able to switch the Wi-Fi back on from the Network icon in the Taskbar Notification area: select this and make sure the Wi-Fi button is blue and the Flight Mode is grey. If they're opposite colours, click them to hopefully resolve your problem.

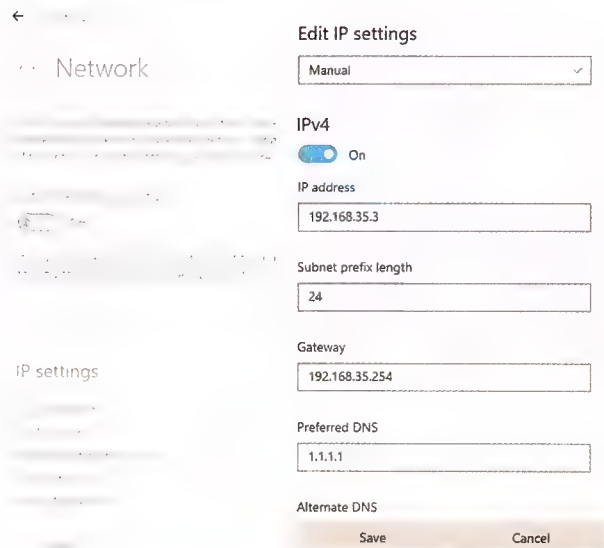
TROUBLESHOOT IN WINDOWS

Still no connection? The step-by-step guide opposite carries you through the basic troubleshooting options offered by Windows 10. When it comes to installing driver updates, you'll need to port them across using a USB stick, then either run the setup.exe file or – if it's just a folder of files – return to the Driver tab in Device Manager, click Update Driver and choose 'Browse my computer...' to manually locate the folder containing the driver file.

If everything appears in order, but you're still not getting connected, you might want to try manually setting



A misfiring firewall can cause havoc with your internet connection – eliminate it as a cause.



Try setting a manual IP address if you think your router isn't assigning an address to your PC.

"If you're able to see your path to the internet through your router, but still can't connect to network services, the problem may lie with your firewall."

your connection instead of letting your router assign a network address: open 'Settings > Network & Internet > Status' and click 'Change connection properties', then scroll down and click Edit under IP Settings.

Select Manual, then make sure IPv4 is enabled and fill in the fields: Subnet prefix length is 24, the Gateway is the IP address of your router, and IP address is the unique IP address you're assigning to your PC: note the first three numbers (192.168.x) are the same as your router, but the final number is one between 0 and 254 that's not being used by another device on your network. While you're here, set the Preferred DNS to 1.1.1.1 and Alternate DNS to 1.0.0.1 to use CloudFlare DNS to resolve internet web addresses.

Click Save and see if things now work – if they do, the problem may lie with your router's DHCP server (turn the page). If they don't, you can set things back to 'Automatic (DHCP)' and continue with the troubleshooting.

TROUBLESHOOT YOUR FIREWALL

If your path to the router is visible, but the internet itself is down across all

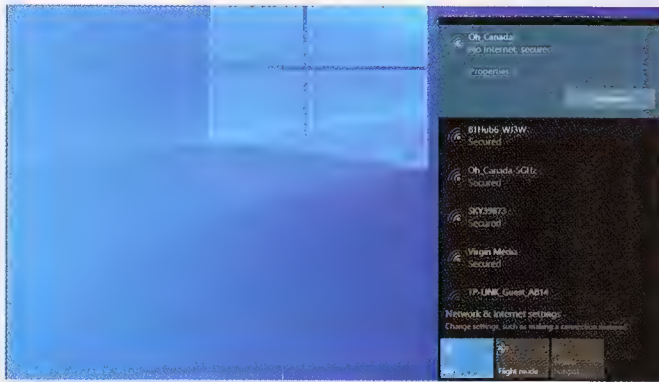
your networked devices, turn the page; if you're able to see your path to the internet through your router, but can't connect to some or even all network services, the problem may lie with your firewall. Start by attempting to disable it temporarily: look in your security software's dashboard for an option to switch off the firewall. If you're a Windows Firewall user, type "command prompt" into the Search box, then click 'Run as administrator' underneath it before typing the following command:

```
netsh advfirewall set allprofiles state off
```

If disabling the firewall resolves your connection problem, look for an option to reset it (go to 'Start > Settings > Update & Security > Windows Security > Firewall & network protection' to click 'Restore firewalls to default' for Windows Firewall). Visit the security software's help pages online for further troubleshooting advice – including how to remove and reinstall your security software if necessary.

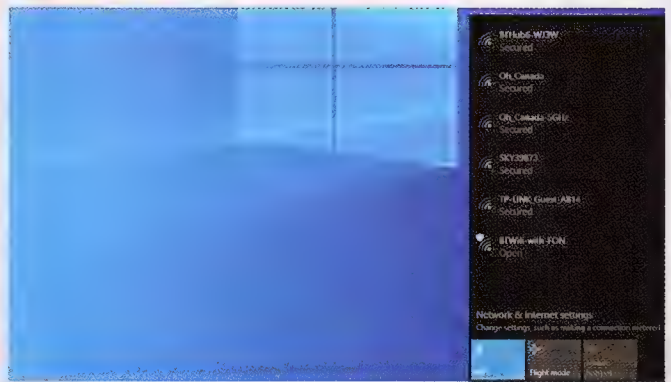
Whatever you do, don't forget to re-enable your firewall ('netsh advfirewall set allprofiles state on' in the case of the Windows Firewall).

Diagnose connection issues in Windows 10



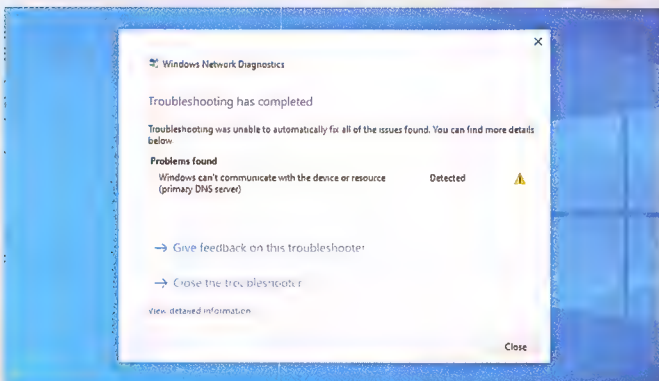
1 CHECK NETWORK STATUS

Your first port of call should be the network icon in the Taskbar Notification area. A yellow exclamation mark confirms your connection but indicates a problem; a red cross indicates no connection. In either event, click the icon to see a more detailed diagnosis.



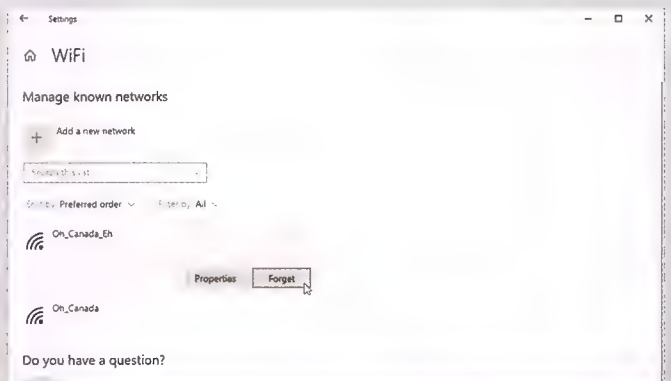
2 NETWORK MISSING

A globe icon indicates you're disconnected, but that your adapter is working and other connections are available – if interference is an issue, you may find another of your own networks (say 5GHz instead of 2.4GHz) is available. Try connecting through that.



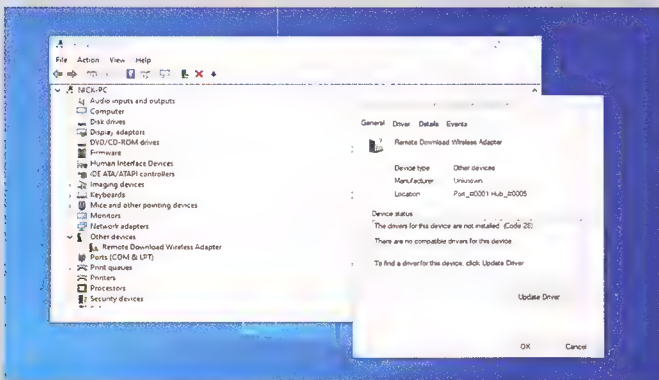
3 RUN NETWORK TROUBLESHOOTER

Click 'Network & Internet settings' to open Settings. The Status section should reveal if – and where – your connection has broken. If it's broken between the connection and the internet, turn the page. If not, scroll down and click 'Network troubleshooter' to see if Windows can find a fix.



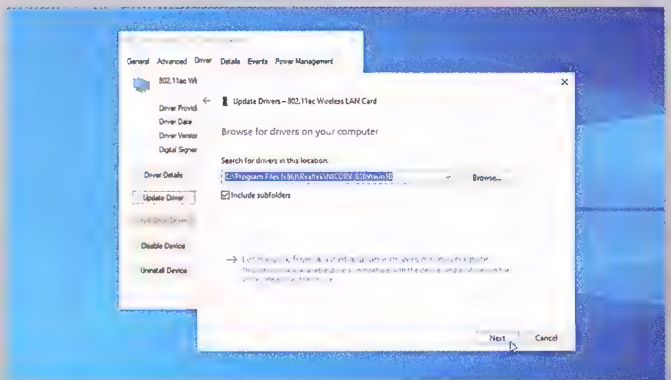
4 FORGET KNOWN NETWORKS

If the troubleshooter fails to clear the problem, select WiFi in the left-hand pane and click 'Manage known networks'. Select your non-functioning network from the list and click Forget. Once the settings have been removed, see if you can connect again from the Taskbar notification area icon.



5 CHECK WI-FI DRIVERS

If your network stopped working after a recent hardware or Windows update, press Win-R, type "devmgmt.msc" and press Enter to check Device Manager. Look under Network Adapters to see if there are any issues flagged – double-click your network adapter and check under the Drivers tab.



6 RESOLVE DRIVER ISSUES

If the driver version indicates a recent update, try undoing it by clicking 'Roll Back Driver', then rebooting when done. Failing that, check your network adapter or PC manufacturer's website on a working PC to see if an updated driver or other troubleshooting information is available.

Fix wider network faults

Nothing connecting to your network? Internet access down? Read on to discover how to troubleshoot.

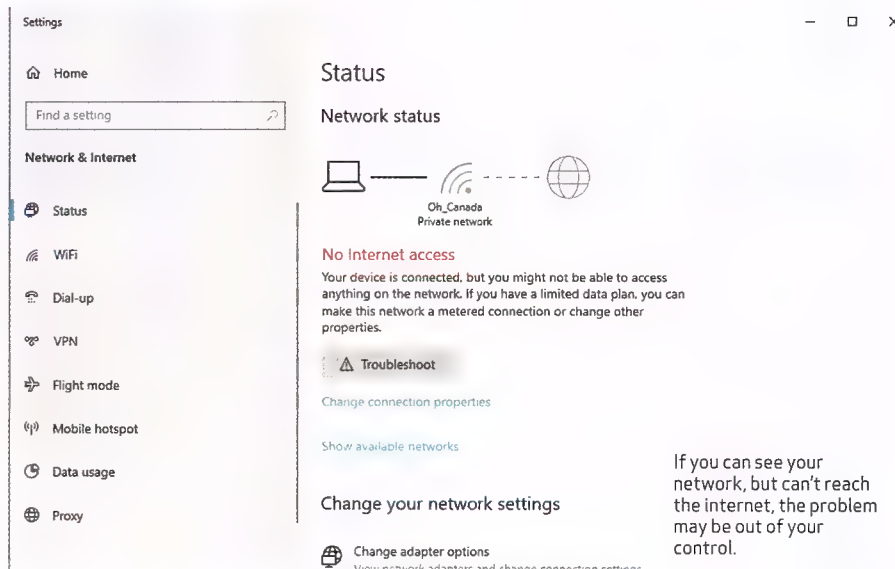
At the heart of your network lies your modem router, which provides a conduit to the internet (as well as other shared network resources) for all your wired and wireless devices. If you run into connection problems on all your devices at the same time, the cause can usually be traced to a problem with your router.

The adage "have you turned it off and on again?" is never more aptly applied than to your router. It's usually on 24/7, and many problems can often be fixed simply by switching the router off via its power button or the plug, waiting 30 seconds for its memory to clear, then switching it on again. Wait a couple of minutes for things to get up and running, then retry your connections.

NETWORK CONNECTIVITY

First, verify if your devices have a connection to the router – first open File Explorer and select Network in the Navigation pane. If your router appears under Network Infrastructure, double-click it to open your web browser at its configuration page; if not, navigate to Start > Settings > Network & Internet > Status and click 'View your network properties' to see if your PC has been assigned an IP address and what the default gateway address is.

If one is visible, open your web browser and type that IP address in – you should be redirected to the router's configuration page. If it fails to connect, or no gateway address is



If you can see your network, but can't reach the internet, the problem may be out of your control.

shown, then check on your other devices via their network settings page (for example, Settings > Wi-Fi > Advanced on your Android phone) to see if they've been assigned an IP address. If so, try connecting to your router through that browser.

If you have a HomePlug network and the problem only appears to be affecting devices connected through that, first verify the diagnosis: plug your PC directly into one of the router's Ethernet ports and see if it can now connect. If it does, go online or check your HomePlugs' documentation for the

steps required to completely reset the entire HomePlug network – typically reset the plug connected to your



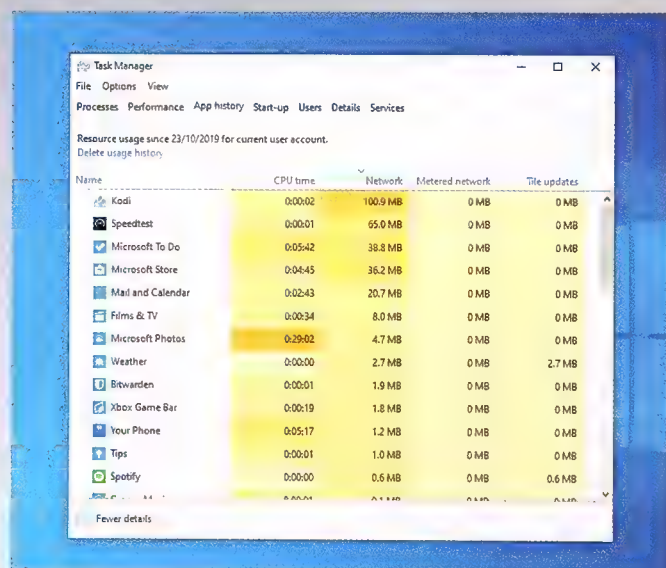
HomePlug problems can often be fixed by simply resetting all the plugs and starting again.

Resolve speed issues

To determine what speed you're actually getting (as opposed to what your broadband provider claims), start by visiting your router configuration utility and look for the current and maximum rates (remember to divide kbps by 1,000 to get the equivalent figure in Mbps). These should be considered your benchmark rates.

In reality you won't get anywhere near these rates, but get in the habit of performing regular tests using a tool such as www.speedtest.net. You'll find speeds vary according to time of day based on how many users are sharing your connection – you may also find speeds capped during peak rates if you're a heavy user. Check your ISP's pages for details of its fair-use policy.

Remember your connection is shared between all the devices on your network, so periods of slow performance may coincide with family members gaming online, or choosing to stream a movie in 4K instead of HD. It may also be down to an individual application on your PC – cloud sync apps can bring connections grinding to a halt without upload and download limits in place – use Task Manager to track network usage.



router, then repeat for the other plugs on the network.

The direct ethernet connection test should also be applied to verify network problems aren't restricted to your wireless network. If you're now able to connect, check (and, if necessary, reset by disabling and then re-enabling) your router's Wi-Fi networks to hopefully bring things back online.

If your router still refuses to be reached however you're connected to it, then it may be time for the nuclear option: look for a factory reset setting on the back of the router and be prepared to set everything up from scratch again: your internet logon details, Wi-Fi setup and don't forget to change the router password and disable remote access to your router for security reasons.

INTERNET CONNECTION FAULTS

If you've got full access to your local network, but your internet connection has stopped working, that usually indicates the fault is outside your control. Double-check the cable between your router and the phone line, but otherwise the key is either waiting for a fix or finding an alternative internet connection to use to verify that the problem is an external one.

For most people, the backup connection will be your phone's mobile broadband connection. If your PC has Wi-Fi, you can try tethering it to your

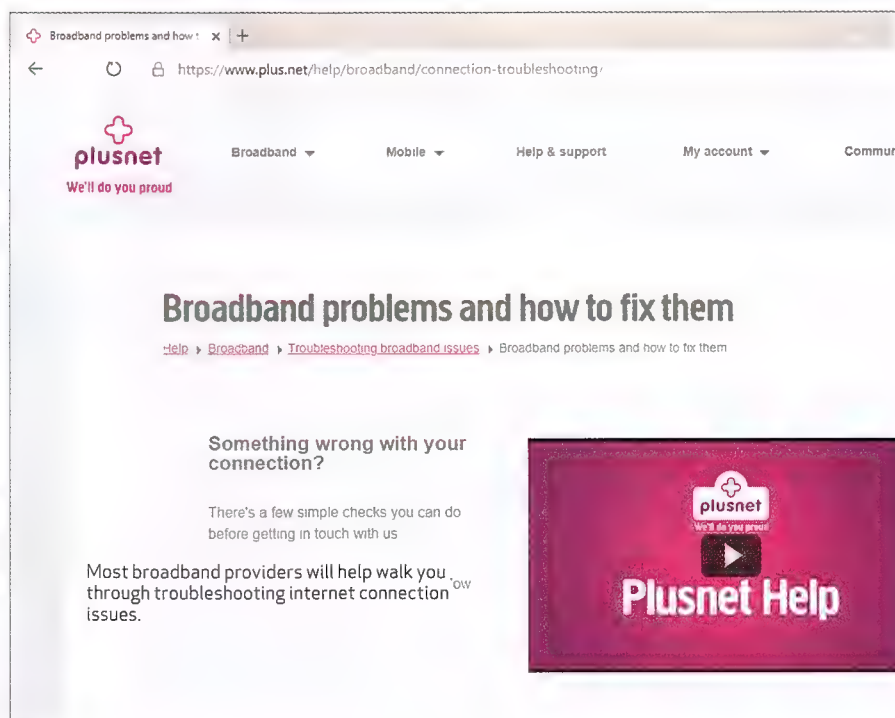
phone's connection: Settings > Personal Hotspot on the iPhone, Settings > Wireless > More on Android. Once set up, click the Network icon in the Taskbar notification area on your PC to connect.

If you're in range of a neighbour's Wi-Fi network, you might want to ask them if they'll kindly give you access. If they're understandably reluctant,

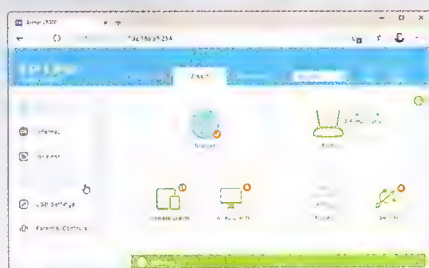
ask them to temporarily enable their guest network as outlined in the step-by-step guide below. Once done, visit your internet provider's support pages to locate its status page (or Google the ISP name and 'status') to see if there's a known issue in your area. If nothing shows up, you can check your ISP's support pages for more help and points of contact should you need them.

After you've restored your internet connection or found out what's going on, have the courtesy to let your neighbour know and invite them to disable the guest network for security purposes. You might also want to offer to set up your own guest network for them in return as an act of good will.

"Your router is usually on 24/7, and many problems can often be fixed simply by switching the router off, waiting, then switching it on again."

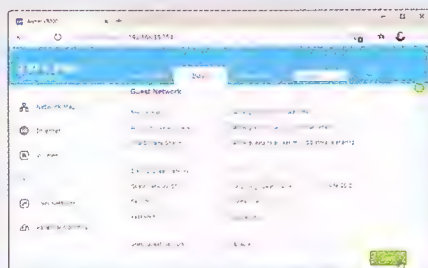


Set up a guest network



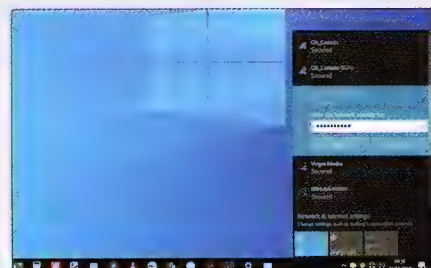
1 LOG INTO ROUTER

Ask your neighbour to log into their router's configuration page via their web browser – look on the router for login information if required. Look for the section on Guest Networks – it may be buried inside the Advanced or Wireless section if it's not immediately visible.



2 CONFIGURE

You should only need the 2.4GHz guest network – the 5GHz one is unlikely to reach into your home. Make sure your neighbour sets a strong password (shared with you) and that they leave all options for seeing or sharing other guests or the main network disabled.



3 CONNECT TO NETWORK

Return home and you should see the guest network in your list next to your neighbour's main network. Click Connect, enter the network key and click Next again. When prompted to make your PC discoverable, click No. You should now have temporary internet access.

Fix niggling Wi-Fi problems

Not all issues bring your network grinding to a halt. Here's how to troubleshoot, maintain and improve your wireless performance.

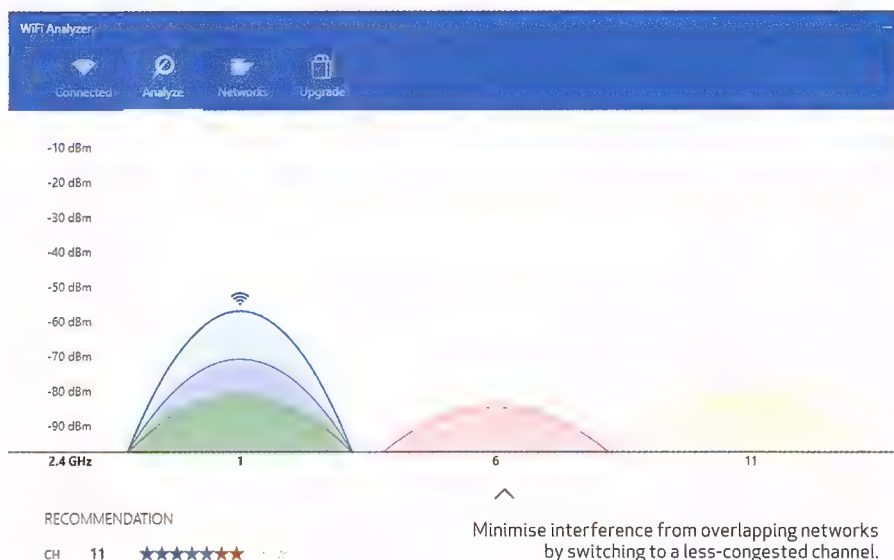
One major bottleneck in getting good transfer speeds is your wireless connection. Despite the eye-catching speeds advertised, the reality is much less appealing. Performance drops off the further you are away from the router – particularly on the newer 5GHz network bands. There are also problems caused by interference – both through local network congestion from too many competing devices within your own network, plus neighbours' Wi-Fi signals swamping your own.

FIX WIRELESS INTERFERENCE

Before looking at improving overall signal strength, look to tackle interference from overlapping networks as well as competing demands from the ever-growing number of connected devices in your own home. Start by focusing on network interference by installing Matt Hafner's free WiFi Analyzer app from the



Modern 802.11ac router antennas can be moved to try to direct a stronger signal in a specific direction.



Microsoft Store.

Launch the app, choosing Europe when prompted. Click Close, and let the app toggle your Wi-Fi and Bluetooth connections on and off when asked. Start with a look at your current network, including a glance at the network speed. Review the icons beneath the signal strength meter – any coloured orange or flickering between orange and black signify a potential problem, such as network interference (star icon).

Switch to the Analyze tab where you'll see your network's signal appear on a

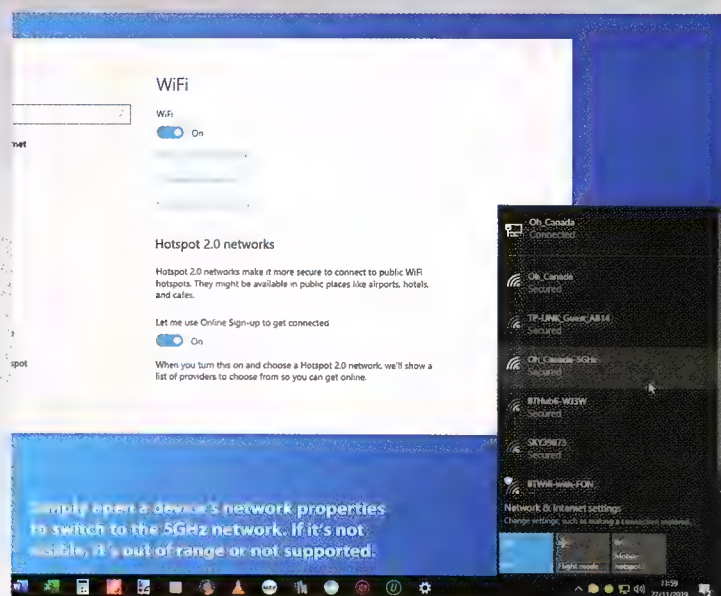
graph along with neighbouring networks – all typically as curves over the numbers 1, 6 and 11, which indicate the channel each network is transmitting on.

Beneath this graph is a recommendation for which channel your network should transmit on – if it's a different channel to the one currently set, you'll need to open your browser and navigate to your router's configuration page. Locate your 2.4GHz wireless settings and look for a channel option – set this to the recommended number, save your changes and wait

Move to 5GHz

It's not just interference from neighbouring networks you need to consider when troubleshooting your 2.4GHz connection: internal network congestion is also an issue, particularly if you have numerous wireless devices all competing for bandwidth. To reduce overcrowding on the 2.4GHz band, now is the time to consider switching compatible devices to the 5GHz band.

It's a no-brainer if your wireless device is in direct line of sight to the router itself – the 5GHz band is much quicker than 2.4GHz, so you should see speed improvements straight away. Sadly, however, the range at this frequency is far less than the 2.4GHz band, so be prepared for performance to drop off more sharply the further away you are from the router. Nevertheless, you should still be able to shift even a handful of devices across to the new network – more if you make smart use of your Wi-Fi extender (perhaps disable the 2.4GHz band if not needed to allow you to place it closer to the router), all of which will help free up bandwidth for the remaining devices on your 2.4GHz network.



while your PC reconnects. Return to the Connected tab where you'll hopefully see some improvement.

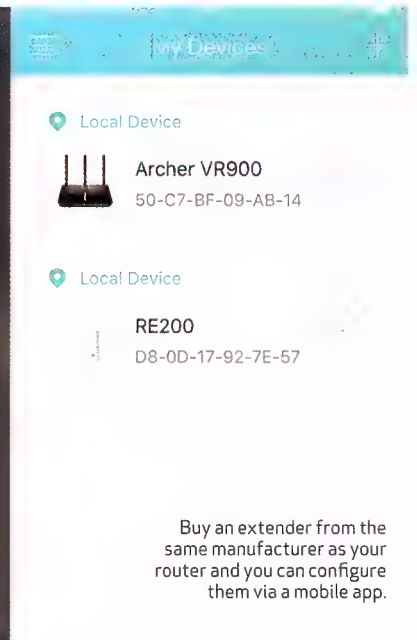
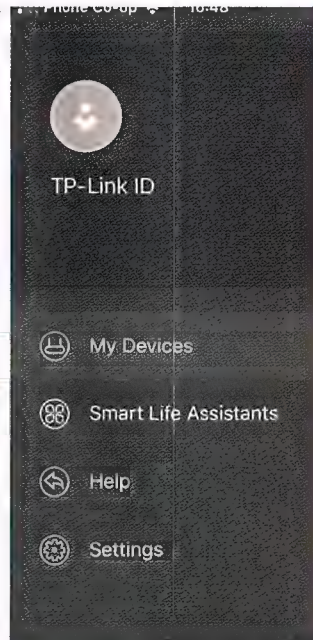
When it comes to reducing demand on your internal network, one solution is to make better use of the under-utilised 5GHz band – see the box on this page for details. Another might be to switch devices to your unused guest network. Make sure it broadcasts on a different channel to your main network, and remember it won't speed up your internet connection, but might help alleviate the demand on your network.

BOOST YOUR RANGE

If your signal flickers between recommended channels – or you can't get a signal at all in a specific location in your home, then the issue is likely to be that your PC is at the edge of your network's range or in a 'dead zone'. Remember that it's not just distance from the router that's critical, but also

My Devices.

range of routers from Tether.



Buy an extender from the same manufacturer as your router and you can configure them via a mobile app.

"It's not just distance from the router that's critical, but also the number of walls the signal has to pass through."

the thickness and number of solid walls the signal has to pass through (which is why you can often connect on the pavement outside your home, but not in a room just a few metres away).

Also eliminate other potential forms of interference on the 2.4GHz band: microwaves, older cordless phones, door chimes and even some wireless mice can all be known to cause disruption. Disconnect the potentially offending item to see if it's the culprit, then consider upgrading it.

If your router comes with two or more

antennae, try aligning one vertically and the other horizontally to see if it can boost your range that bit further. Also consult your router's support website to see if you can upgrade its supplied antennae with more powerful 'high-gain directional' replacements to boost the signal to a specific part of your house. Also consider relocating your router to a more central location or moving it to reduce the number and thickness of walls and solid objects it needs to pass through.

Another way to increase your range is

with a Wi-Fi extender. These cost around \$50, and to simplify setup you should purchase one from the same manufacturer as your router – they can usually be paired usually through a mobile app. This creates a second wireless network from your Wi-Fi extender, which acts as a relay for the original network. See the box below for tips on setting one up.

You might also be tempted by the idea of a mesh network, which links various nodes around your home with each other and the original router to blanket your home with a strong Wi-Fi signal. It's an expensive option, but simple enough to set up and maintain. For most people, however, one carefully placed Wi-Fi extender is perfectly adequate, works with your existing network and works out much cheaper!

Troubleshoot extender issues

If you've purchased a Wi-Fi extender to boost your network's range to a specific part of the house, placing it in the sweet spot between the router and the room you want to extend to is a tricky business. Place it too far from the router and it'll relay at best a weak signal, but if you place it too close to the router than its own signal will compete in terms of signal strength with the router itself. Result? Devices may periodically lose their connection as they struggle to determine which network signal is the best one to latch on to.

If you have a HomePlug network already in place, consider replacing the extender with a HomePlug device that has built-in Wi-Fi. This carries the network signal to your remote room through the electrical wires, ensuring a much stronger signal (and thus faster performance) than a regular extender. The HomePlug should also be sufficiently far from the router to avoid interfering with the original Wi-Fi network, while be sure to set it to the same SSID and password as your router's Wi-Fi network for seamless use.



Some extenders have visual aids to tell you when the signal they're relaying isn't strong enough.

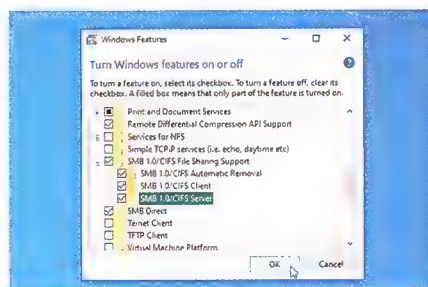
Solve sharing problems

Iron out glitches with sharing files and printers with our handy fix-it guides that cover more than just Windows.

One of your network's principal functions is to share resources between machines, and it's this interaction that can often lead to problems, particularly when it comes to sharing between different platforms, such as PC to Mac, or Windows to Linux. Sometimes glitches can occur even when attempting to share files between PCs running Windows. If one PC doesn't appear on the network, the step-by-step guide reveals the key steps you can follow to make things work once again.

ACCESS OTHER PLATFORMS

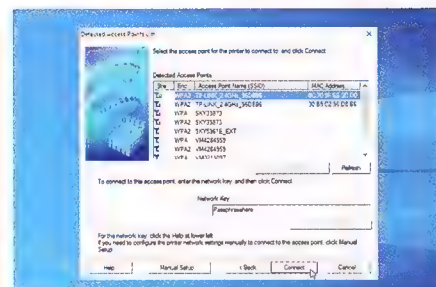
If you want to share files with Linux or Macs, then there are a few tweaks to ensure everything runs smoothly. The simplest thing to do is get everyone else talking the same networking language as your Windows PCs: on the Mac, navigate to System Preferences > Sharing and tick 'File Sharing'. Click Options and verify 'Share files and folders using SMB' has been selected. If you're planning to share files from your



SMB 1.0 is only required to connect to legacy devices, including Apple TimeCapsule drives.

Mac (as opposed to simply access files on other PCs), make sure your username is ticked before clicking Done – anyone attempting to access folders on this machine will need to know your Mac's account name and password.

Ubuntu and Mint Linux users should find SMB sharing is enabled out of the box – just open Files and select Other Locations (Ubuntu) or Network (Mint) and your other networked devices



Some Wi-Fi printers require connection to your PC via USB so they can be connected to your network.

should be visible – click 'Windows Network' followed by your workgroup to see what's visible. If your PC still isn't visible, check the firewall on those computers or try connecting manually: 'Go > Connect to Server' on the Mac, 'File > Connect to Server' in Linux.

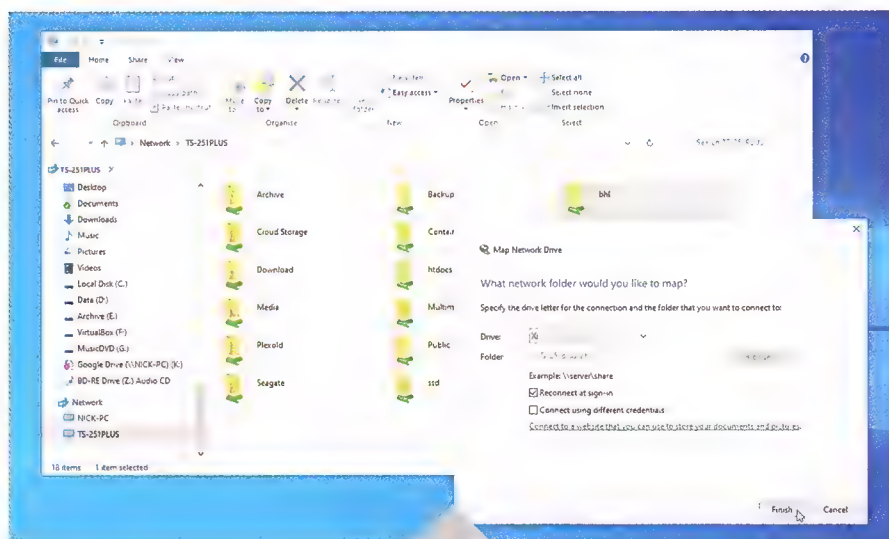
Some older legacy devices may not appear by default either. If your device appears in the list at <https://techcommunity.microsoft.com/t5/Storage-at-Microsoft/SMB1-Product-Clearinghouse/ba-p/426008> then type 'features' into your PC's Search box and click 'Turn Windows features on or off'. Tick 'SMB 1.0/CIFS File Sharing Support' and click OK, rebooting when prompted to hopefully make them visible.

SHARED PRINTERS

These days, most printers come with networking features built in. Plug your printer into a spare Ethernet port and it should be immediately visible when you choose 'Settings > Devices > Printers & scanners > Add a printer or scanner' – visit the manufacturer's website for the latest drivers.

Wireless printers may need a little more work: if the printer has a WPS button, pressing that followed by pressing the WPS button on your router should get things working, or you may need to use its hardware control panel. If all else fails, connect it via USB, install the drivers supplied and look for a point in the installation process where you can connect it to your Wi-Fi network.

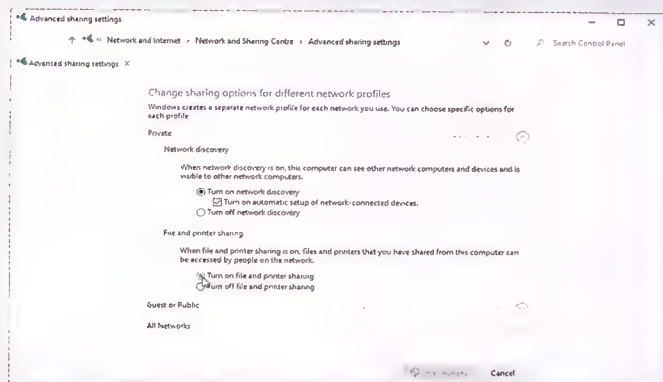
Want to share a standard USB printer? Your router or NAS drive may come with USB ports you can plug it into to share it over the network, or you may have to connect it to your main PC, then go to 'Settings > Devices > Printers & scanners', select the printer and click 'Manage > Printer properties'. Switch to the Sharing tab to share the printer.



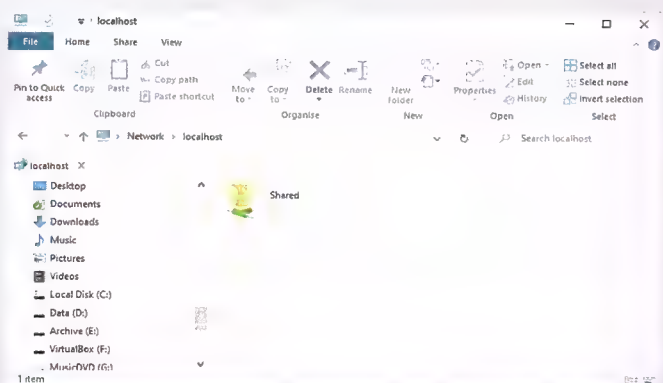
Map drives

Having to manually reconnect to a frequently accessed shared drive each time you start Windows is a pain. Thankfully you can make network folders more accessible by assigning a drive letter to them: browse to the shared folder in question, right-click it and choose 'Map Network Drive'. Select your chosen drive letter, leave 'Reconnect at sign-in' ticked, and click Finish. Your new drive will appear under File Explorer in the 'Network locations' section of This PC. Just click it for instant access going forward (assuming the folder is available) – if necessary, entering your username and password when prompted.

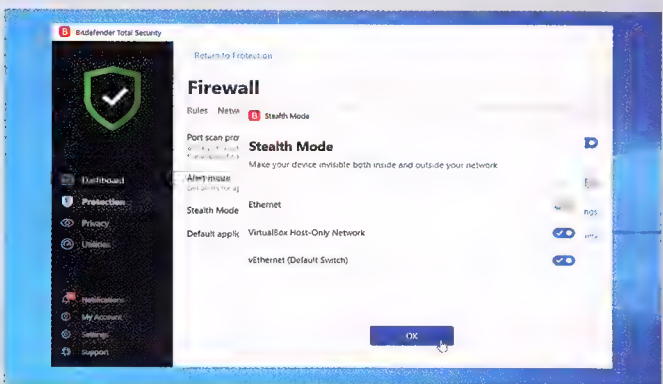
Troubleshoot shared folders



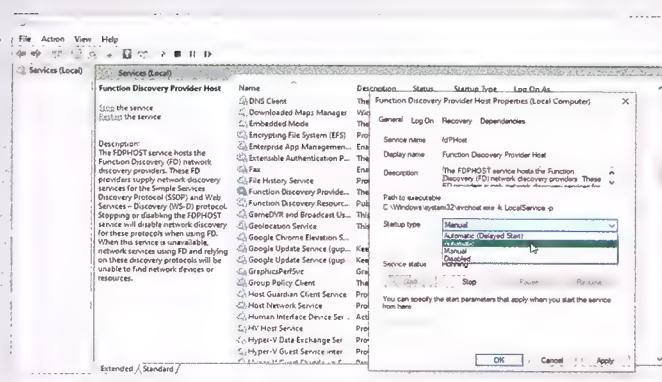
1 CHECK VISIBILITY
On the PC that's not visible on your network, type 'sharing' into the Search box and click 'Manage advanced sharing settings'. Expand Private as shown above and ensure both 'Turn on network discovery' and 'Turn on file and printer sharing' are selected. If necessary, click 'Save changes'.



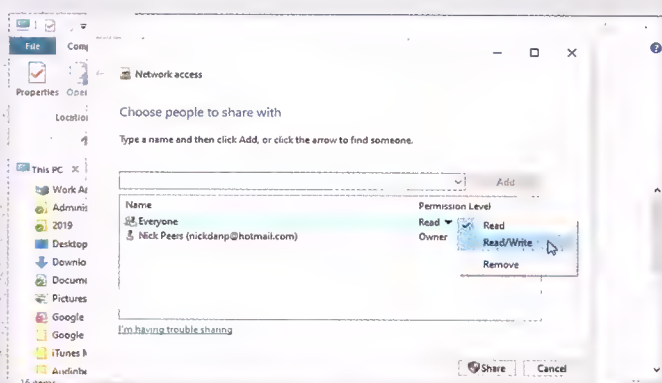
3 CHECK SHARED FOLDER
If the PC still isn't visible, it may not have any shared folders set up: open File Explorer on the PC in question and type \\localhost into the Address bar. If folders are visible here, jump to step five; otherwise right-click the folder you wish to access and choose 'Give access to > Specific people'.



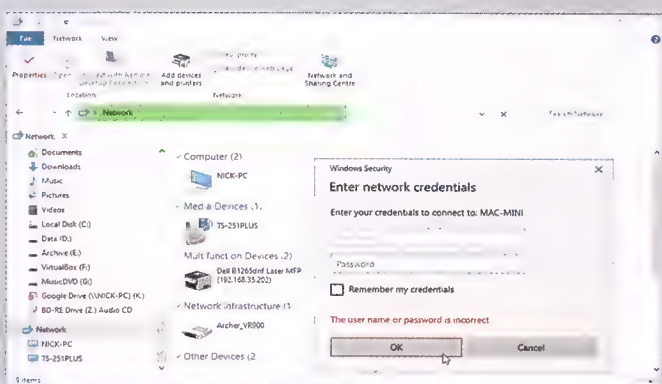
5 CHECK FIREWALL SETTINGS
If you still can't see the PC elsewhere on your network, visit your security software's support website for help troubleshooting network visibility. In Bitdefender choose 'Protection > Firewall > Settings > Settings', click 'Edit stealth settings' and disable your network adapter to make it visible.



2 VERIFY RUNNING SERVICES
Press Win-R, type "services.msc" and click OK. Right-click each of these services in turn and choose Properties, ensuring they're all set to start automatically: Function Discovery Provider Host, Function Discovery Resource Publication, SSDP Discovery, and UPnP Device Host.



4 SHARE FOLDER
The currently logged on account holder's name should already be present – if this is you, click Share. Otherwise, select Everyone from the drop-down menu and click Add to provide any network user with read-only access. Click Read to change the permission level followed by Share.



6 CONNECT THROUGH IP
If a computer still doesn't appear when browsing Network on another PC try typing one of \\PC-NAME or \\192.168.x.y into the Address bar of File Explorer. Substitute PC-NAME with the PC's Device name (Start > Settings > System > About) or 192.168.x.y with its actual IP address.



System News

AMD botched the 5600 XT launch and Mark Williams wants to make sure you know how to navigate it.

At CES in January, AMD announced the next product in the RX 5000 series – the RX 5600 XT. Targeted to beat the GTX 1660 Ti, AMD hit its mark well, showing better performance at the same price point.

Unfortunately for AMD, Nvidia was watching and with a few weeks to go before the 5600 XT actually hit shelves, Nvidia pulled a price shuffle while AMD wasn't looking, resulting in the GTX 1660 Ti reducing a fraction in price but also substantially reducing the RTX 2060's price, bringing it into price competition with the just-announced 5600 XT.

This put AMD in a tough place; it made the 5600 XT look pricey for its performance relative to the GTX 1660Ti and nowhere near as good as the only slightly more expensive (now discounted) RTX 2060.

The RX 5600 XT was shaping up to have a rather dull launch, set to debut in a no man's land in the GPU market, but AMD didn't give up. The day before the 5600 XT launched, AMD issued a VBIOS update that changed GPU boost clocks from as low as 1560MHz all the way up to 1750MHz, as well as increasing the memory speeds from 12Gbps up to 14Gbps and subsequently the TDP up 10W to 160W.

This last-minute play from AMD transformed the RX 5600 XT into quite the exiting product on launch, as the new VBIOS boosted the 5600 XT on average up to on par performance with the RTX 2060! All the while remaining cheaper by up to \$50. Well played, AMD.

Unfortunately, AMD's last minute VBIOS change also meant that all the cards that had been produced for the launch had shipped with the original

VBIOS and it was too late for card makers to pull products back before they hit shelves to update them. As a result, the RX 5600 XT market is a bit of a mine field as to what performance you'll get out of the box and even afterwards.

Non-OC cards will generally be stuck with the original slower 1560MHz boost clocks forever and they won't be getting a VBIOS update, like the MSI Mech (non-OC). Factory OC cards, like the Powercolor Red Dragon and Sapphire Pulse which have out of the box boost clocks of 1620MHz can get the new AMD VBIOS and unlock maximum boost clocks of 1750MHz along with the 14Gbps memory speeds, giving these cards an extra 13% performance for free!

Confusingly, not all 5600 XT OC cards are equal. Many like the MSI Gaming X and Asus ROG Strix cards weren't built with 14Gbps capable memory onboard, meaning if they do get a VBIOS update it'll only affect core clocks, not the much more important memory clocks. In the case of those two cards, new versions in the form of the MSI Gaming Z and Asus ROG Strix Top will replace them and come with 14Gbps memory onboard.

With pricing being so tight across the range of 5600 XT cards, if you're considering buying one be sure to do your research and check if there is VBIOS updates available or that it comes pre-flashed with the new clocks.

If you already own a 5600 XT, be sure to check out your manufacturer's support page for a new VBIOS to apply as you might be able to unlock a big chunk of extra performance. ■

SHOP TALK

Did AMD's launch of the RX 5600XT affect you or sales of the card in any way?

Richard, Aftershock PC:

"The 5600XT has not had much of a take-up in our custom builds in their respective price category and has not noticeably increased the number of AMD cards we have sold. The 1650 Super, 1660 Super and RTX 2060 are still by far the more popular options. At an estimate, only about 5% of our builds currently have AMD GPU's installed. This is in stark contrast to the CPUs of which AMD has taken a huge share from Intel and is still gaining popularity.

We have been flashing the BIOS for all of the 5600XTs we have sent out, so apart from a bit of extra time, this has not really caused us any issue. As we don't sell parts on their own, just fully built PCs, we are opening up, installing and testing all of the 5600XT units prior to shipping them out. This gives us a good opportunity to flash the bios of everyone before sending it to our customers."

John, TI Computers:

"At TI, we always ensure all our prebuilt systems do receive both BIOS and driver updates to the date of its production. They were also fine-tuned to optimal performance and fully stress tested before leaving our shop, hence the impact is negligible at least in our prebuilt business. Overall, we have not seen noticeable impact to our business as the result of this matter."

Market Snapshot

A sampling of PC systems available this month.



Aftershock Hypergate

\$2,899 - [TINYURL.COM/APC479AFT](https://tinyurl.com/APC479AFT)

Aftershock's recommended Hypergate configuration is quite a beast, designed for high refresh-rate gaming. The GPU is the second-best available, saving a large chunk of money while serving up top tier performance, and the same goes for the CPU. However, Aftershock is by default installing the F variant of the 9700, meaning not only does it have no iGPU, but it also has no overclocking abilities – which for this grade of system is a letdown for enthusiast buyers. The \$100 difference for the KF version at checkout is pricey, but could be worth it for those wanting to overclock, but as it is, it makes the AIO somewhat overkill, though it certainly adds to the aesthetics and will keep the system quiet.

KEY SPECS: CPU: Intel Core i7-9700F, **COOLER:** NZXT Kraken X63, **MOTHERBOARD:** Asrock B365 PRO4, **GRAPHICS:** Asus Dual GeForce RTX 2080 Super 8GB, **MEMORY:** 16GB Apacer Zadak Moab RGB 3600MHz DDR4, **STORAGE:** 512GB M.2 NVMe SSD, 2TB 7200RPM HDD, **POWER SUPPLY:** FSP / EVGA 600W, **CASE:** NZXT H510 Elite.



PC Case Gear Force 2080 Super

\$2,799 - [TINYURL.COM/APC479PCC](https://tinyurl.com/APC479PCC)

Coming in a fraction cheaper than the Aftershock system this month, this rig delivers similar performance but via a different approach. With the graphics cards being the same, this system certainly has the same gaming chops, but with an AMD 3700X installed it won't be quite as effective at extracting every FPS at the high end at 1080p. If you want to game at 1440p or higher though this CPU won't hold you back at all. And with double the thread count on offer, you might even prefer this system for other productivity work you do when not gaming. Oddly the overclocking and cooling situation is reversed here. This system can be overclocked, but it's stuck with the stock HSF.

KEY SPECS: CPU: AMD Ryzen 7 3700X, **COOLER:** AMD Wraith Prism, **MOTHERBOARD:** Asus Prime B450M-A, **GRAPHICS:** Asus GeForce RTX 2080 Super Dual OC EVO 8GB, **MEMORY:** Corsair Vengeance RGB Pro 16GB 3200MHz CL16 DDR4, **STORAGE:** Adata XPG SX8200 Pro M.2 NVMe SSD 512GB, Seagate Barracuda 2TB HDD, **POWER SUPPLY:** be quiet! Pure Power 11 600W, **CASE:** Lian. Li Lancool One Digital.



Mwave S605i Gaming PC

\$3,199 - [TINYURL.COM/APC479MWV](https://tinyurl.com/APC479MWV)

Stepping up in price, this gaming rig dons a more exciting 9700KF, allowing for that sweet overclocking goodness that Intel parts do so well. Expect to be able to push well into the 5GHz range with the included 360mm AIO watercooler.

The 1TB NVMe SSD is a notable standout from the other systems this month, doubling what others are offering and potentially allowing you to ignore the included 2TB HDD.

The case has your typical tempered glass front, but has ample breathing holes around the front to not choke off the front fan intakes, which is often the case with poorly designed cases. Case airflow should be solid for good CPU and GPU temps.

KEY SPECS: CPU: Intel Core i7-9700KF, **COOLER:** Cooler Master MasterLiquid ML360R ARGB AIO, **MOTHERBOARD:** MSI MPG Z390M Gaming Edge, **GRAPHICS:** Gigabyte GeForce RTX 2080 Super Gaming OC 8GB, **MEMORY:** 16GB Thermaltake DDR4 RGB 3200MHz, **STORAGE:** Crucial P1 1TB NVMe M.2 SSD, Seagate 2TB 7200RPM HDD, **POWER SUPPLY:** Unknown, **CASE:** Cooler Master Masterbox MB530P.

TI Computers Power Ryzen 9 3900X

\$3,245 - [TINYURL.COM/APC479TIC](https://tinyurl.com/APC479TIC)

Coming in as the most expensive system this month, it's also unsurprisingly the most capable. While it won't keep up with the Intel based systems if you're after super high refresh rate gaming at 1080p, it'll do well, and once you bump up the resolution to 1440p and above you won't notice a bottleneck at all.

What you will notice is triple the CPU thread count! The 3900X will let you get some serious compute work done fast. Paired with a massive 32GB of memory it opens up a lot of productivity options for users.

The case is on the cheap side, and for a 12-core CPU, the cooler choice could've been better, but with that much compute power available and PCIe 4.0 who'd complain?

KEY SPECS: CPU: AMD Ryzen 9 3900X, **COOLER:** Cooler Master Hyper 212 Turbo, **MOTHERBOARD:** Asus Prime X570-P, **GRAPHICS:** RTX 2080 Super 8GB, **MEMORY:** 32GB DDR4 Kingston 3200MHz, **STORAGE:** 500GB Samsung 970 EVO Plus NVMe M.2 SSD, Seagate 2TB HDD, **POWER SUPPLY:** GA or EVGA 750W, **CASE:** DeepCool Matrexx 55 RGB.



PC blueprints

The APC team's picks for a part-by-part perfect PC build to suit your budget.



PARTS LIST

PART		PRICE
CASE	BITFENIX NOVA TG	\$75
PSU	THERMALTAKE SMART BX180+ 450W NEW	\$65
MOTHERBOARD	GIGABYTE B450M DS3H NEW	\$115
CPU	AMD RYZEN 5 2600	\$199
GPU	EVGA GEFORCE GTX 1660 SUPER BLACK 6GB	\$419
RAM	8GB (2X 4GB) PATRIOT VIPER 4 BLACKOUT SERIES @ 3,000MHZ NEW	\$73
SSD	120GB ADATA SU650 SATA III	\$30
HDD	1TB WD BLUE HDD	\$59
OS	UBUNTU DESKTOP LINUX 18.04.3 LTS 64-BIT	\$0
APPROXIMATE PRICE:		\$1,035

We're making quite a few changes this month. First (forgive us for not going down the list in order) we tweaked the RAM by a small amount, swapping from Patriot's Viper Elite memory to the Viper 4 Blackout to kick the frequency up to 3,000MHz from 2,666MHz in the old build. Bigger changes came in the form of a new PSU, Thermaltake's Smart 450W model, and a manufacturer change for the motherboard, sticking with the B450M format, but swapping to Gigabyte's budget model. Everything else stuck around in terms of price; the Ryzen 5 2600 still comes with three free months of Xbox Game Pass, so snap that up.

PARTS LIST

PART		PRICE
CASE	FRACTAL DESIGN MESHIFY C	\$149
PSU	SILVERSTONE 500W ET500 BRONZE	\$59
MOTHERBOARD	GIGABYTE X570 UD NEW	\$225
CPU	AMD RYZEN 5 3600X	\$369
COOLER	AMD WRAITH SPIRE	N/A
GPU	MSI RADEON RX 5700 MECH OC 8GB NEW	\$539
RAM	16GB (2X 8GB) G.SKILL AEGIS @ 3,200MHZ NEW	\$119
SSD	480GB ADATA SU630 M.2 PCIE SSD NEW	\$99
HDD	1TB WD BLUE HDD	\$59
OS	WINDOWS 10 HOME 64-BIT OEM	\$140
APPROXIMATE PRICE:		\$1,758

Rejoice! The Asrock X570 Phantom Gaming 4 is finally no longer on sale, and a new contender has risen to claim the "cheapest X570 motherboard" crown. As usual there's not much in it, though, with MSI and Asrock within a few dollars. It's Gigabyte once again, though, with its X570 UD board – fairly similar to the outgoing board, really. We're trading out our memory for G.Skill's Aegis line, sticking with 16GB and 3,200MHz to keep our performance in line without letting the price rise. \$10 is saved by switching to an MSI 5700 graphics card – one with a small but appreciated factory overclock, too. And, with SSD prices getting ridiculously low we found a very nice Adata drive for under a hundred dollars for 480GB.



UPGRADE OF THE MONTH

MSI GeForce RTX 2080 Super Ventus 8GB

\$1,099, [MSI.COM](https://www.msi.com)

It's almost ridiculous how good value this model of Nvidia's excellent RTX 2080 Super is. This is the card that makes 4K gaming more viable; or 1440p ultra, with ray tracing on. Don't get us wrong, it's still a lot of money for a GPU, but right now it's hard to recommend anything else for powerful gaming systems. With 8GB of VRAM at 15.5Gb/s and a tasty 1,830MHz boost clock, this is a powerhouse card that is edging closer and closer to half the price of its big brother, the still-ludicrously-expensive RTX 2080 Ti. It's great, and it's never been better value.

"Remember to hop into the BIOS to adjust the memory settings, making sure your memory is running at full speed."

The RTX 2080 Super GPUs are still dropping in price, almost alarmingly so. But we're not complaining; \$1,100 for the 2080 Super Ventus from MSI is a fantastic deal that we recommend to anyone building a high-end system. We've made a few changes to our Turbo build this issue, with another memory shift, going to G.Skill's Ripjaws V memory, but sticking with the same specs. Hopefully soon we'll be able to buff up the memory in these systems. ■

PARTS LIST

PART		PRICE
CASE	NZXT H700I	\$229
PSU	850W CORSAIR RM850 80+ GOLD	\$189
MOTHERBOARD	ASUS PRIME X399 TR4 NEW	\$459
CPU	AMD THREADRIPPER 2950X	\$1,199
COOLER	COOLER MASTER MASTER LIQUID ML360 RGB	\$179
GPU	MSI GEFORCE RTX 2080 SUPER VENTUS 8GB	\$1,099
RAM	32GB (2X 16GB) G.SKILL RIPJAWS V SERIES @ 3,600MHZ NEW	\$249
SSD	1TB GIGABYTE AORUS GEN4 NVME M.2 PCIE SSD	\$388
HDD	2X 3TB SEAGATE BARRACUDA COMPUTE HDD	\$360
OS	WINDOWS 10 HOME 64-BIT OEM	\$140
APPROXIMATE PRICE:		\$4,302

GAMING POWERHOUSE

We set out to assemble a powerful eight-core PC for gaming. Break out the LEDs with Christian Guyton.

We started out with a budget for this. Our initial idea centered around an eight-core CPU and a Radeon RX 5700 XT, but this was soon scuppered by the arrival of a beautiful, mirror-fronted RTX 2070 Super FE at the APC office. The price rose, and our CPU/GPU cost ratio skewed, so up we went from a Ryzen 7 3700X to the 3800X – sticking with our eight-core plan.

Of course, a gaming PC needs more than just a good CPU and powerful graphics. We needed an X570 motherboard to support that chip, and those don't come cheap. The addition of memory and a non-stock cooler drove us over our original budget. And so, this build shifted; no longer a sensibly priced machine, but a gaming powerhouse. Treasure this rare glimpse into the inner workings of APC, where the temptation to throw money at a build is ever-present.

We didn't go too overboard; this isn't a Dream Machine, after all. So, 16GB of high-speed RAM and lots of storage – 3TB, to be exact. If you can't download your whole Steam library, what's the point? High-speed 2.5G ethernet and Wi-Fi 6 connectivity from our mobo mean that downloads shouldn't even take too long (if your internet connection is up to scratch).

We're also opting for the full "gamer" treatment, which means RGB lighting, of course. We've got some specific fans in for that, courtesy of Fractal Design – a few to replace the existing fans in our Thermaltake case, and a couple of extra ones to improve the case airflow. Our CPU likely won't be bearing the bulk of work done by this PC – with a gaming rig, auto-overclocking for the GPU is important – so overall airflow is more significant than dedicated CPU cooling.

All five case fans we're using are translucent plastic with RGB LEDs inside, and our CPU cooler also features RGB fans. The memory uses RGB lighting, too; the motherboard is LED-free, but its black-and-gray finish will contrast nicely with whatever color scheme we decide to use. We're also including a 30cm RGB lightstrip from Asus's Republic of Gamers line, to provide the ultimate in case illumination, although this is an optional addition that we found buried in our gear cupboard and decided to use, so feel free to skip it. Our case has large tempered glass side panels, so the guts of this machine will be fully on display.

That means cable management and general tidying, but we'll get to that. We'd like this to be a PC that you can show off to your less technologically capable friends; a monument to the fact that you are the superior system builder as well as the superior gamer. Let's get to it!





POWERHOUSE PC INGREDIENTS

PART		STREET PRICE
CASE	THERMALTAKE A500 TG	\$319
M/BOARD	MSI MEG X570 UNIFY	\$479
CPU	AMD RYZEN 7 3800X	\$549
CPU COOLER	COOLER MASTER MA610P	\$65
GPU	NVIDIA GEFORCE RTX 2070 SUPER FE	\$799
MEMORY	16GB (2X 8GB) CORSAIR DOMINATOR PLATINUM RGB DDR4-3600	\$265
PSU	760W FRACTAL DESIGN ION+ 760P 80+ PLATINUM	\$209
BOOT DRIVE	1TB CORSAIR MP600 SSD	\$379
STORAGE DRIVE	2TB SEAGATE BARRACUDA	\$92
FANS	FRACTAL DESIGN PRISMA AL-14 (2X) AND AL-12 (3X)	\$120
OPERATING SYSTEM	WINDOWS 10 HOME	\$140
TOTAL		\$3,416

POWERHOUSES PINGREDDIENTS

CPU

AMD RYZEN 7 3800X

\$549



A recent price drop makes the 3800X even more attractive. Yes, in a powerful build, there's potential to use the 12-core Ryzen 9 3900X, but that would result in a significant price increase for only marginally better gaming performance. The 3800X is now less than \$70 more expensive than the 3700X, but brings a significant increase to standard operating frequency while packing the same eight-core architecture. Fully unlocked for overclocking, PCIe 4.0 support for superfast SSD transfers, and a low 105W TDP all serve to sweeten the deal.

CPU COOLER

COOLER MASTER MA610P \$65

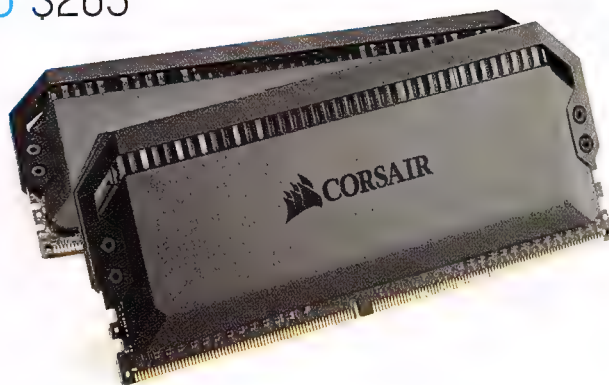
Surprise! We're using air cooling for this build. There's no stock coolers to be seen here, though; the Cooler Master MA610P is a stylish air cooler, with a tall heatsink flanked by two snap-on fans. In addition, it comes with brackets that enable it to be attached to either Intel or AMD platforms (no Threadripper, though). The two fans are uniquely shaped to give the MA610P a slick rounded form that eschews the blockiness of many air coolers.



RAM

CORSAIR DOMINATOR PLATINUM RGB 16GB (2x 8GB) DDR4-3600 \$265

We've championed the Dominator Platinum before, and this time is no different; the Platinum RGB runs fast and looks good. The solid metal exterior and 12 addressable RGB LEDs per stick scream "high-end," and the performance is among the best available. We contemplated a 32GB kit, but increasing memory capacity provides diminishing returns for gaming performance. We're keeping the frequency high, letting our Ryzen CPU get the most out of the 3,600MHz memory speed.



MOTHERBOARD

MSI MEG X570 UNIFY \$479

If we're using a third-gen Ryzen processor, we want the right board. That means the X570 chipset, and X570 motherboards were prohibitively expensive after Ryzen 3000's initial release. Now, you can snag an X570 board for under 250 dollars, but we're not cheaping out; MSI's MEG X570 Unify is perfect, providing great all-around performance. Plenty of heatsinks mean that this system will stay cool, while Wi-Fi 6 and 2.5G LAN provide the best internet connectivity for online gaming.



GPU

NVIDIA GEFORCE RTX 2070 SUPER FE \$799

The RTX 2070 Super Founders Edition looks even better than older FE cards, with a mirrored center panel to reflect RGB lighting. With 8GB of GDDR6 video memory and a boost of 1,770MHz, this is a super-powered graphical heart for our rig. It supports native resolutions up to 8K, it's VR-ready, and it's prepped for ray-tracing action. It is a bit pricey compared to models from other manufacturers, though, so feel free to stick with your preferred brand.





PSU

760W FRACTAL DESIGN ION+ 760P 80+ PLATINUM \$209

A powerful build such as this needs a good power supply. Fractal Design might have only recently ventured beyond the case kiddie pool and dipped its toes into the PSU shallows, but the Ion+ series are excellent power supplies. Rated to 80+ Platinum for maximum performance and longevity, this model provides 760W for our system, which should be more than enough, leaving a little room for expansion if needed. The RTX 2070 Super needs 215W and the processor draws 105W, which means there's still plenty of overhead. Oh, and it's fully modular, too, saving us from having to bundle excess cables away beneath the PSU shroud.

SSD

CORSAIR MP600 1TB \$379

The fact is that PCIe 4.0 M.2 drives are still relatively uncommon; only five major manufacturers have released their versions, and the MP600 remains the best value. Plus, it's a great drive; this system should be hitting close to that glorious 5,000MB/s transfer rate, loading games and everything else a PC this powerful would be doing extremely quickly.



FANS

FRACTAL DESIGN PRISMA AL-14 AND AL-12 \$120

That's two 140mm fans and three 120mm fans, to be precise. Some of these will be replacing the existing case fans; one 120mm at the rear, and two 140mm Prismas at the front of the case. It's a shame that they'll be hidden by the solid metal front plate, but these fans are bright, shining through to illuminate the rest of the case. We're going to be putting the other two 120mm fans on the case ceiling, providing some extra cooling, while also adding further lighting to this build with six addressable LEDs per fan.



HDD

SEAGATE BARRACUDA 2TB ST2000 DM001

\$37

It's an older hard drive, sir, but it checks out. This early Barracuda (that's right, not "BarraCuda") HDD brings 2TB of storage space on a hefty 7,200rpm rectangle, perfect for storing all your movies and images. Really, just about any 7,200rpm hard drive from a reputable manufacturer should do the work; the drive we're using is several years old, but uses the same SATA connection as any other modern HDD. Seagate's products are good quality, although if you're buying this drive online, be aware that it may not include a SATA connector cable. There should be one included with the motherboard, however.

CASE

THERMALTAKE A500 TG \$250

If you're the gym-shy type, you won't be by the time you're done with this build. The A500 TG from Thermaltake is somehow simultaneously gigantic and super-sleek, an obelisk of dark brushed aluminum and tempered glass that weighs over 30 pounds. Lifting and positioning this case is not a task for the faint of heart—remember, bend at the knees, and get someone to help if you need it. Weight aside, this case is excellent, constructed to an extremely high standard and equipped with multiple drive trays and plenty of space for the extra fans we're going to be using.

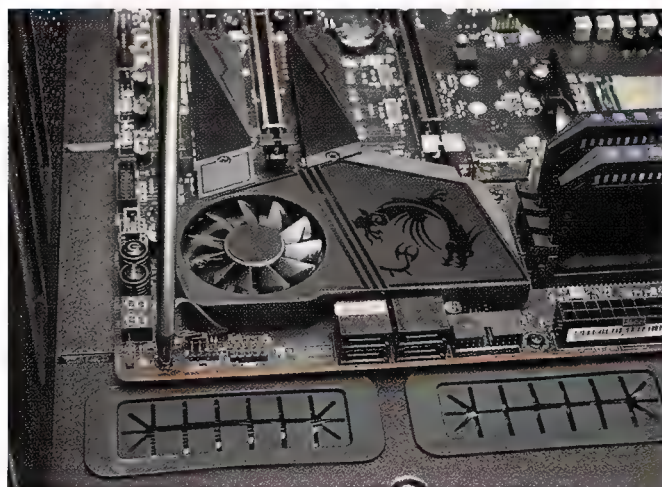


BEGIN BUILD THE



1 EXCESS EXTRACTION

Let's begin with a case stripdown. Start with the side panels, which open with a latch and a magnetic clasp, and can then be lifted off their hinges. Be careful with the glass panels! Put them in the box until you're finished. The metal front panel pops off with a bit of force. The top panel comes off the same way, but needs more care to avoid damaging the front I/O. We left that one on for now, as it only needs removing when installing the case fans later. Remove the drive cages above the PSU shroud, as we're not using them and they'll hamper airflow. You can remove the vertical GPU mount, too. Lastly, remove the case fans, and donate them to a pal with a dusty case.



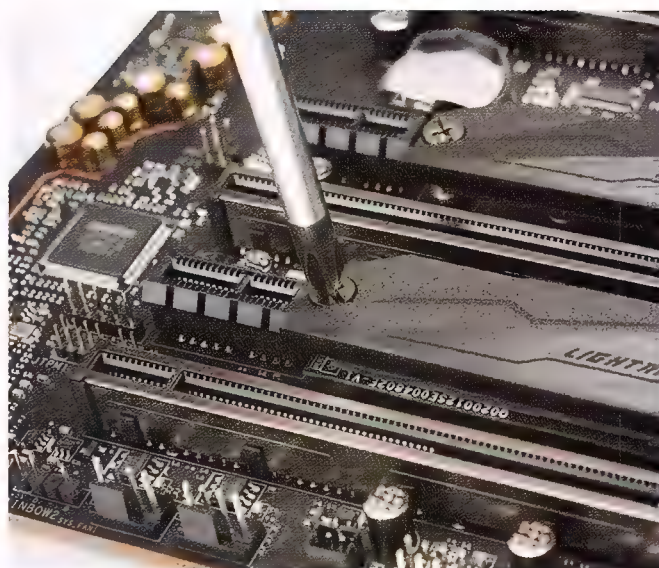
4 MOTHERBOARD MOUNTING

Time to put that board inside the case. Often, we'd recommend fitting an air cooler before doing this, but the MasterAir MA610P is a big cooler that'll get in the way of our fan installation. Before you mount the board or get stuck in with fans, though, take a look at the various screwpoints and standoffs around the case. You might want to file some of these down; during our build, blood was spilled when an errant thumb caught the sharp edge of an unused screw hole. Remove the largest M.2 heat shield from the motherboard first, as it covers the hole for the central mounting peg. Lower the board in, making sure all the holes line up with the standoffs and the rear I/O, before screwing it down with the circular screws. Once secured, replace the M.2 shield.



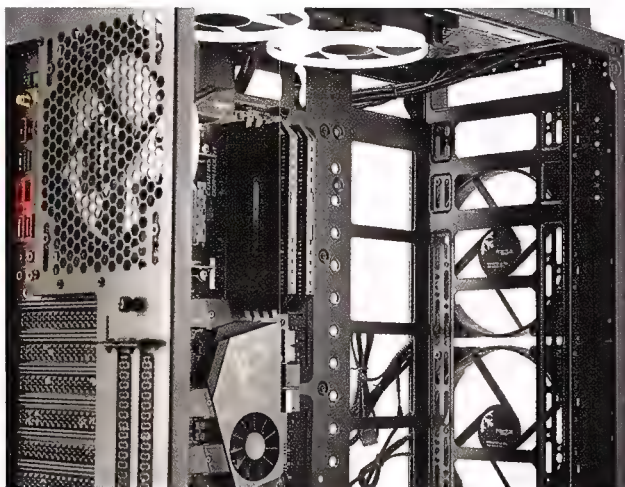
2 PROCESSOR PRIMED

Grab your motherboard and put it on top of its box, or on your workbench. Don't let the board touch the outside of the antistatic bag it comes in – only the interior of the bag dispels static, the exterior can have the opposite effect. Install the CPU by lifting the metal retention arm, carefully dropping the chip into the socket, and lowering the arm to lock it into place. Remember to align the little gold triangle on the corner of the chip with the triangle on the bracket. Next up is memory; there's a little printed direction on the board highlighting which two DIMM slots you should be using, in this case A2 and B2, the second and fourth slots away from the CPU socket. Simply open the clasps at either end and slot the RAM into place, making sure that both clasps click shut.



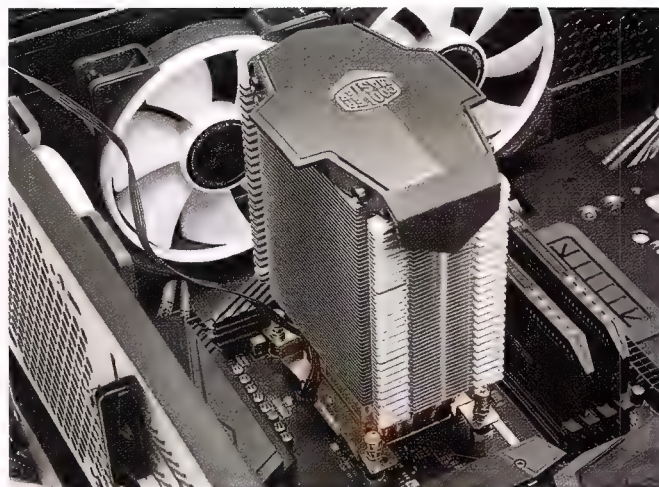
3 DRIVE DILEMMA

It's time to deal with our drives. First up is the HDD. Remove the two screws from one side of the drive tray (it doesn't matter which side) and release the plastic clasp beneath. That lets you slide one side out to widen the tray, at which point you can insert the drive, making sure to align the holes on the side of the drive with the two blunt screwheads. Then reset the plastic clasp and return the two screws you removed, screwing them in to secure the drive, then return the tray to the cage. Next: the M.2 SSD. Remove the heatsink from the MP600 drive by unclipping it on each side and extracting the drive. Unscrew the motherboard's heatsink and slot your drive into place, then remove the cover on the sticky heat pad, and push it down over the drive to screw it back into place.



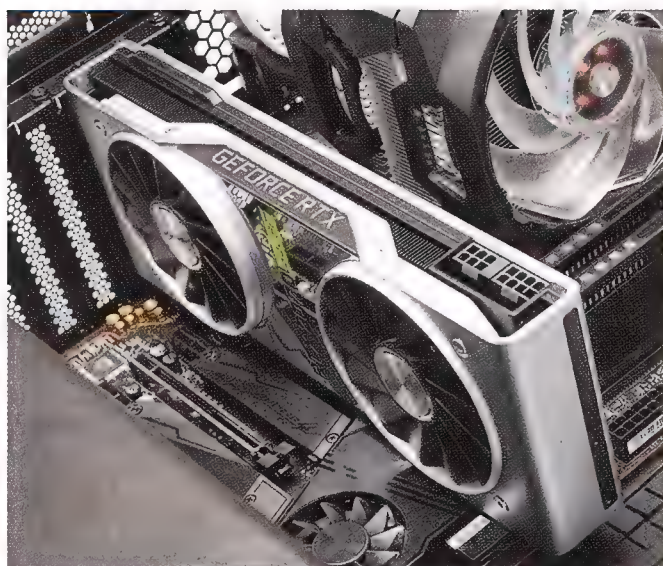
5 FAN FOLLY

Pop off the top panel if you didn't earlier, then check the fan casings for arrows indicating airflow; the 140mm fans should draw air in, and the 120mm fans should expel it from the case. We started with the rear fan first, using one of the 120mm Prismas, holding it in place, and affixing the screws from outside the case. Be sure not to overtighten them, as it can warp the aluminum frame of the case. Move on to the front, fitting the two 140mm fans so they are both clear of the PSU shroud. Lastly, install the two 120mm fans to the case ceiling. Be sure to feed through the cables from all the fans, installing them so the cables are closest to the hole you're going to feed them through. Leave them bundled for now, though, or they'll get in your way during the PSU installation.



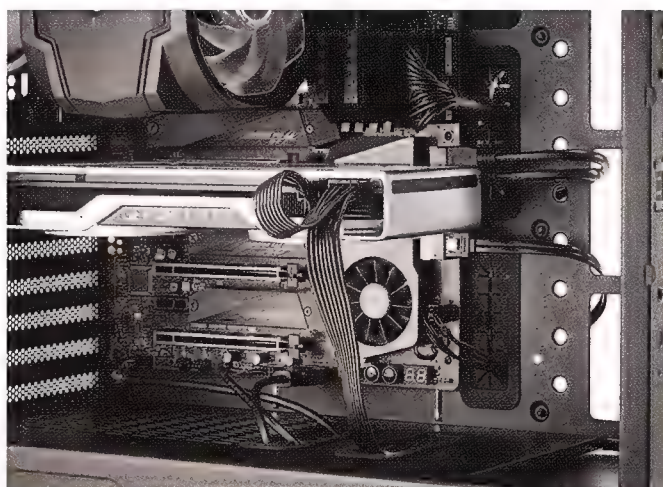
6 COOLING CRISIS

You'll likely want the MA610P's manual here. You need to use the AMD side of the backplate, fitting the square-headed screws and locking them in place with plastic caps. Make sure the backplate fits through the four holes around the CPU socket, then push it through from beneath, and screw on the standoffs. Next, attach the AMD brackets to the base of the heatsink tower, then remove the two fans, before screwing it down over the CPU with a small glob of thermal paste between the chip and the copper plate. Plug the fans back in and snap them on to the heatsink, then connect their power cables to the mobo on the CPU fan and pump headers. Check the fans are the right way around, to feed air toward the back. Feed the RGB cable through to the back of the case.



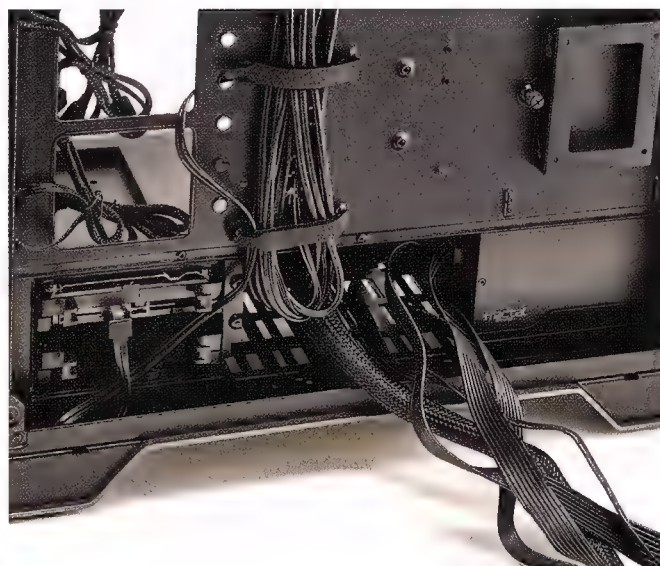
7 GRAPHICAL GOODNESS

Now we've got a nice easy step: GPU installation. Remove two of the blanking plates covering the rear I/O, setting the screws aside for later (we recommend keeping the plates in the GPU box), then make sure the clasp on the PCIe slot is open, and push the GPU down into it until it locks in place. With the card in position, take the two screws and return them to their original position to secure the GPU. There's not much else to be done here, so pour yourself a nice refreshing drink, and take a short break to slap a Band-Aid on your thumb. Speaking of thumbs, we advise you to keep your digits well clear of the reflective central plate on this 2070 Super, because it's a positive magnet for grubby fingerprints that'll ruin the glorious pure aesthetic of the card.



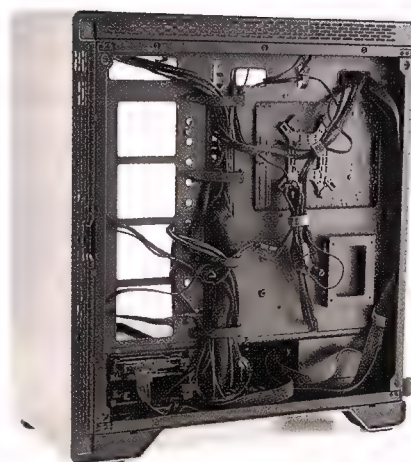
9 CABLE CAPERS

On to the power cables. Untie the front I/O cables, as they can get in the way of threading cables into the main case cavity. Do them in size order, starting with the large ATX mobo power cable. Fitting the CPU power cables can be a squeeze up in the top corner of the case, so listen for the click of the connectors locking into place. The accessory cable is likely to have a lot of slack, so bundle it with any other excess cable lengths, between the PSU and the drive cage. Now move on to the front I/O cables, tucking any slack back into the Velcro strips in the case. The tiny power and LED cables are the trickiest. Find the closest hole in the frame to each connector, then thread through your cables, and secure them to the rear of the motherboard plate with cable ties or Velcro strips.



8 PSU POSITIONING

Nearly done. Unscrew the rectangular plate from the rear of the case and unpack your PSU, keeping the power block and cables separate for now. Use four of the screws included with the case to affix the plate to the power block, then sort through your cables. You need five: a 24-pin ATX motherboard power cable, a split-end GPU cable (this should have two split eight-pin connectors on one end), a SATA cable for the hard drive, and two eight-pin CPU power cables. The system will run fine with just a single eight-pin cable, but the second one adds power for overclocking. Feed the cables through the hole in the rear of the case, then slide the PSU into place, and secure it with the thumbscrews on either side. Take this opportunity to plug in the SATA cable for the HDD, too.



10 FAN FITTING

Untie the bundled fan cables. Feed through and plug in the power cables to the four-pin connectors closest to each one, then separate the RGB cables and daisy-chain them to each other. Each cable has a male and female connector, so you should have one of each type of connector left. Leave the male one unconnected, and plug the female one into the three-pin RGB connector on the mobo. Double-check that the cooler fans are connected to the same RGB cable via the two tiny connectors that run through the heatsink, then plug the RGB cable on to the four-pin header on the motherboard. Secure any remaining slack cables, and return all the panels to the case.



- 1 The case airflow is excellent, with air being expelled from the rear and upper side vents.
- 2 Corsair's iCue software can be used to customise the 24 addressable LEDs we've got in our memory.
- 3 The construction quality of the A500 TG case is unquestionable, but it's seriously heavy; a lot of work to carry about.

Big, Blue, and Beautiful

Looking at the numbers, we're pleased with how this turned out. Roughly 20 percent performance improvement over our zero-point 1440p system is in line with the theoretical improvement of the 2070 Super over the GTX 1080 that system uses, and broader graphical performance in Fire Strike Extreme is great, too. The eight cores of the Ryzen 7 3800X work hard, hitting a good score in Cinebench R15 with no overclocking.

There's room for overclocking in both the CPU and GPU. The 3800X can hit as high as 4.5GHz with a manual overclock, potentially higher on individual cores with Ryzen Master's auto-overclocking mode – although you're constrained by the silicon

lottery to a degree; the highest manual clock we reached was 4.3GHz. Cooling is well handled by this case, with great airflow that kept idle temps very low. The GPU and memory idle at 28 C, while the CPU varies from 30 C to 45 C.

At maximum stress, the CPU peaked at 68 C, proving that air cooling is very much a viable option. Running graphical benchmarks didn't see the GPU temperatures rise above 60 C, either. This system should be able to play just about any game on 1440p ultra settings, with ray tracing as a definite option as well, provided you're willing to drop your settings a tad to keep the frame rates steady. GPU overclocking makes 4K ultra a distinct possibility in some games, too.

Were we to build this rig again, we'd make a few tweaks. You might be wondering why we removed all the case fans when there's room for at least one or two to stay – that's because the MEG X570 Unify only has seven fan headers, and our build has seven fans. Seven independently powered fans, anyway; if you include the GPU and mobo fans, this is a 10-fan machine. It's surprisingly quiet, though, as the Fractal Design case fans are designed for minimum noise.

A fan controller might have been a good addition, allowing for a couple of extra fans in the front and roof, while adding hardware RGB control. We didn't use the small physical RGB controller included with the MA610P cooler, because it wouldn't have been properly compatible with the fans. A PWM fan hub would improve control; using the pump header for a fan means the fan curves have to be manually tweaked in the BIOS.

Talking of which, remember to engage A-XMP in the BIOS. Running the memory at full speed is important when using an AMD processor; while some programs only see very minor improvements, Cinebench R15 saw a 9 percent rise in performance when A-XMP was turned on. There's also Game Boost, which cuts your core use in half, but drew a few extra frames out of each game on our list (the figures in the table are using A-XMP only). Using Game Boost increases fan noise, though, so experiment with it. ■

BENCHMARK RESULTS

	ZERO-POINT	THIS SYSTEM
CINEBENCH R15 MULTI (INDEX)	959	2,144 (124%)
CRYSTALDISK QD32 SEQUENTIAL READ (MB/S)	3,442	4,971 (44%)
CRYSTALDISK QD32 SEQUENTIAL WRITE (MB/S)	1,706	4,252 (149%)
RISE OF THE TOMB RAIDER (FPS)	95	107 (13%)
TOTAL WAR: WARHAMMER II (FPS)	55	70 (27%)
TOM CLANCY'S GHOST RECON WILDLANDS (FPS)	48	58 (21%)
3DMARK: FIRE STRIKE (INDEX)	9,128	11,813 (29%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our zero-point consists of an Intel Core i5-8400, 16GB (2x 8GB) of Corsair Vengeance LPX @ 2,666MHz, an MSI GeForce GTX 1080 Armor, and a 500GB Samsung 960 Evo M.2 PCIe SSD. All tests were performed at 1440p at the highest graphical profile.



Workstation upgrade

Stretching the concept of an upgrade to ridiculous levels, we give a gaming PC a workstation makeover.

We're doing things a little differently from normal this month. Instead of building a system from scratch, we're upgrading one of the office machines to better handle the multithreaded world in which we increasingly find ourselves. The machine in question is the test system I use on a daily basis, and while it has served me well for a couple of years, it is starting to show its age, and as we're surrounded by so much hardware, it feels like a good time to upgrade to something a bit more current. A bit more future-proof.

The starting point isn't a bad machine by any means: It features an Intel Core i7-7700K at its heart, along with 16GB of RAM, and a GeForce GTX 1080 graphics card. If there is a problem, it's on the storage side of things. The Samsung 840 SATA SSD is a little slow (particularly when it comes to write speeds), but at 250GB, the issue is more the fact that it's too

cramped to install more than a few apps on, and I often find myself having to clear out junk in order to stop the drive filling up. This has forced me to turn to the big spinning hard drive more and more, which isn't exactly speedy.

Not everything needs to be thrown out in the upgrade. The Phanteks P400 case needs dusting, but other than that, it's a quality unit that will live on after the upgrade. The 3TB hard drive is also worth hanging on to, although upgrading to an M.2 NVMe drive should mean I'm not as reliant on it anyway. Finally, the PSU has plenty of capacity for a serious upgrade, and I'll be hoping to hang on to that as well. Everything else is up for grabs, though, which makes for quite the upgrade.

OFF THE CUTTING EDGE

There's one defining factor when it comes to picking gear for this build: the intention to use hardware from the APC cupboard that won't be needed elsewhere. This pretty much crosses off anything that has just been released, and indeed favors gear that is no longer available. The sort of stuff you can pick up on special offer from online retailers, or eBay if you're brave enough.

The plan is to embrace the multithreaded landscape of all tomorrow's parties, so we start by grabbing a Threadripper CPU. The AMD Ryzen Threadripper 2970WX, to be exact. This last-gen chip may lack the raw bandwidth of Gen4 PCIe, but it still boasts an incredible 24 cores, or 48 threads, and offers the kind of power that was unheard of only a few years ago. Such CPUs are still widely available, and there are bargains to be had if you shop around.

The next obvious component is the motherboard, and here we turn to the Asus Prime X399-A, a solid option. We did need to upgrade its BIOS for it to support the second-gen Threadripper – something to bear in mind if you're looking to replicate such a build – but having first-generation chips to hand made this a straightforward task.

As for the graphics card, upgrading from a GeForce GTX 1080 is a big ask, but we happened to have a GeForce RTX 2080 that has been retired since the introduction of the Super rendition of the card, so this was a great opportunity to put the original 2080 to long-term use in this build.

The rest of the components fell into place after this, with 32GB of colorful HyperX Predator RAM, a slightly aging 1TB Samsung 960 Pro M.2 drive, and Cooler Master's ML240P Mirage AIO CPU cooler representing the most up-to-date component in the machine. This was used mainly because we don't have a lot of TR4-compatible coolers available, but also because it's a really good cooler.

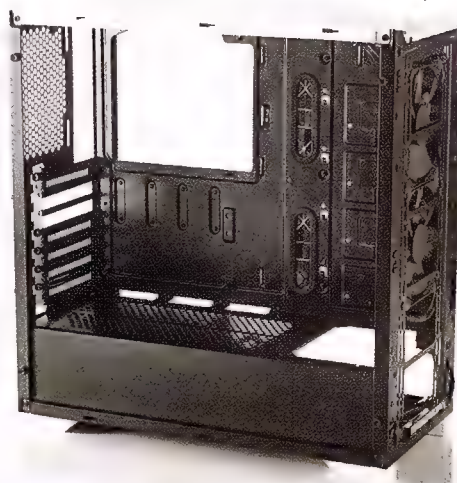
PARTS LIST

PART		STREET PRICE
CASE	PHANTEKS P400 (GLACIAL WHITE) TEMPERED GLASS EDITION	\$N/A
MOTHERBOARD	ASUS PRIME X399-A	\$459
CPU	AMD RYZEN THREADRIPPER 2970WX	\$1,549
CPU COOLER	COOLER MASTER MASTERLIQUID ML240P MIRAGE	\$189
MEMORY	32GB (4X 8GB) HYPERX PREDATOR RGB DDR4 2,933MHZ	\$323
GPU	NVIDIA GEFORCE RTX 2080 FOUNDERS EDITION	\$1,300
PSU	BEQUIET STRAIGHT POWER 11 850W	\$N/A
SSD	SAMSUNG 960 PRO M.2 1TB	\$499
HDD	WESTERN DIGITAL 3TB RED	\$N/A
OS	WINDOWS 10 HOME 64-BIT	\$N/A
TOTAL		\$4,319



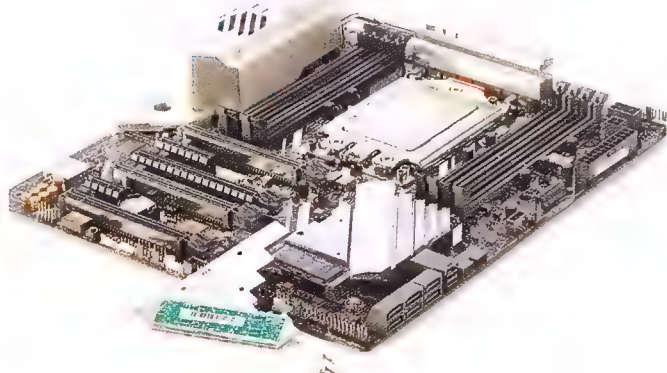
1 OUT WITH THE OLD

We start as we always do with any build – by stripping down the case to its bare skeleton. As this case houses a whole system already, this is slightly more convoluted than normal, but still isn't too tricky. We start by releasing the two thumbscrews that hold the retention bar over the expansion slots, and then unscrew the two thumbscrews holding the graphics card in place. Release the clip at the bottom of the card, disconnect the two power cables, and the card slides out with ease. We also remove the rear fan at this point, and set it aside for later.



2 CLEAR THE DECKS

Next we set about removing the old motherboard. We disconnect the power connectors, along with any other cables that are easy to unclip, before unscrewing the nine screws holding the motherboard in place (a magnetic screwdriver is your friend here), and easing the motherboard out gently, setting it to one side. The front panel of the Phanteks P400 case pops off easily, affording easier access to what's left inside. We initially left the two fans at the front of the case in place, but as you'll see, had to scrap that idea in the end, and we should have removed them from the start. The only thing left in the case at this stage should be the PSU.



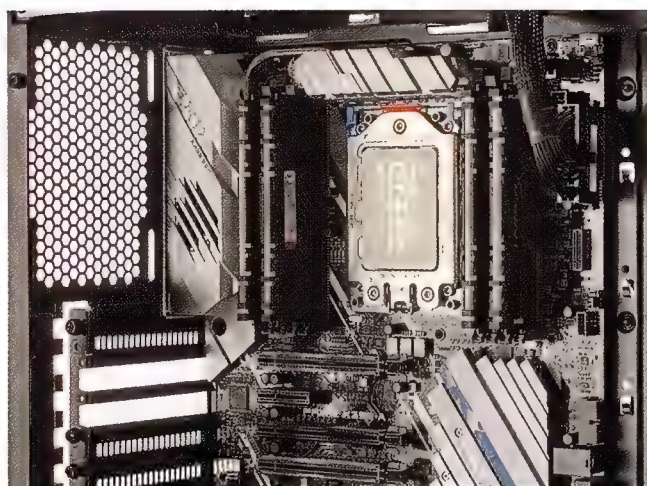
3 IN WITH THE NEW

With the case prepared, we can turn to the core of the new system. We start by installing the CPU in the Asus Prime X399-A. Threadripper motherboards have a slightly convoluted system for inserting the CPU, but the order you release and tighten the three Torx screws is clearly marked, and easy to follow. Once done, we install the M.2 drive by removing the chunky heatspreader toward the bottom of the motherboard, then screw the drive in place using the mounting peg and screw that can be found in the motherboard box. After this, we install the RAM sticks, and the core of the system is ready.



4 BUILT TO COOL

All-in-one CPU coolers are great, especially when you're looking at something as powerful as Threadripper, but they're still a bit of a pain to set up for the first time. The ML240P Mirage is actually one of the easiest ones we've put together, at least. Simply attach the brackets either side of the CPU block (the right way around – align it with the motherboard to check the holes line up), screw them in place, and then attach the fans to the radiator. Be mindful of the fan cables as you do this, because they need to be able to stretch to the motherboard headers once everything is in place.



5 BIG INSTALLATION

It's now time to slide the motherboard into place. Don't forget to clip the I/O shield in position beforehand. The motherboard is loaded up with the CPU, SSD, and RAM at this stage, and is weighty, so be careful as you ease it in. Screw it down on to the offsets using the nine screws you removed earlier. The next step is to attach the AIO cooler. It's at this point we discovered there wasn't room to install the radiator in the roof of the case, so we removed the front fans in order to install it there instead. Fix the radiator in place using standard screws.



6 FINISHING FLOURISHES

Slide the GeForce RTX 2080 into place, and secure it with the thumbscrews before attaching the power cables – we couldn't thread these up from the bottom, because we couldn't get the clips through, so instead we routed these from the side instead. Speaking of which, you can now connect the rest of the cables – both power connectors and the case's front panel leads. This is a roomy case, and we didn't have too many problems here. The only issue we had was with the RGB lighting of the AIO cooler, but we wanted subtle lighting anyway, so didn't pursue this. We finish off by screwing in the old HDD and connecting its cables, and we're done.



1 The tubes on all-in-one CPU coolers can be unwieldy beasts, and while we wanted them to come out of the top of the block here, we just couldn't get them to do so, and so settled with them coming out of the bottom.

2 We initially intended to place the radiator in the roof of the case, but the radiator block and fans were too large to fit above the motherboard, so we went for front mounting instead. If needed, we can always reinstall the front fans in the top.

3 There's no obvious place to mount hard drives in this case, other than at the front here, on top of this removable plate.

A serious upgrade

Before upgrading, this machine was fine for gaming, and could turn its hand to more serious work at a push. The aging storage was holding it back, though, and it did feel sluggish in even day-to-day tasks at times. After the upgrade (or complete rebuild, if we're honest), this machine is an absolute powerhouse – look at the Cinebench result below if you need proof (the zero-point results were taken from the machine before its upgrade). That storage overhaul means that it feels smooth and responsive across the board; no need to go and make coffee whenever a huge app or game is fired up.

The overall build went well, and

there isn't much we'd change. Obviously, we're lucky having so much gear to hand – flashing the motherboard BIOS, for instance, just required slotting in a first-gen Threadripper, updating the BIOS, then swapping back to the second-gen chip. Something that took less than half an hour, as opposed to weeks getting a replacement motherboard.

There's still room to add extra fans, and we may fight the cabling to try to add a little color, but there's no need for this rig to be lit up like the Vegas strip to enjoy its thread-heavy power. The lighting from the mobo is subtle, and there's just enough light from the RAM

and graphics card to see that it's all working OK when you hit the power button.

Returning to the performance, there was one anomaly when testing, and that was in *Total War: Warhammer II* – we saw a modest increase at 4K, as shown, but at lower resolutions, the frame rate was stuck in the mid-30s. We knew switching to Game Mode in Ryzen Master would improve this a little, but weren't expecting to hit almost three times the frame rate at 1080p compared to Creator Mode – it really does make that much difference in this one game. At 4K, the frame rate jumped up to 43fps, which is a notable improvement. The other games weren't affected anywhere near as much, just a frame or two at 4K. So, we'll stick with all the cores and threads of Creator Mode unless we spot sluggish behavior.

The upgrade from a GeForce GTX 1080 to an RTX 2080 hasn't blown us away. 3DMark Fire Strike may be a synthetic test, but it's a good indicator of power, and the 7 percent improvement of the RTX 2080 over the GTX 1080 speaks volumes. Gaming performance is improved, especially when the Threadripper is in Game Mode, but even here, it isn't enough for us to recommend such an upgrade. At least we can experience real-time ray tracing now, albeit not at 4K. ■

BENCHMARK RESULTS

	ZERO-POINT	THIS SYSTEM
CINEBENCH R15 MULTI (INDEX)	946	4,279 (352%)
CRYSTALDISK QD32 SEQUENTIAL READ (MB/S)	496	3,445 (595%)
CRYSTALDISK QD32 SEQUENTIAL WRITE (MB/S)	196	2,111 (977%)
RISE OF THE TOMB RAIDER (FPS)	51	65 (27%)
TOTAL WAR: WARHAMMER II (FPS)	32	36 (13%)
TOM CLANCY'S GHOST RECON WILDLANDS (FPS)	31	37 (19%)
3DMARK: FIRE STRIKE (INDEX)	17,347	18,571 (7%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our zero-point consists of an Intel Core i7-7700K, 16GB (2x 8GB) of HyperX Savage DDR4 @ 3,000MHz, an MSI GeForce GTX 1080 Gaming X, and a 250GB Samsung 840 SATA SSD. All tests were performed at 4K at the highest graphical profile.

howto

» QUICK TIPS

Experts solve your computing problems

The APC team tackle problems across the spectrum of devices and software we use. Learn a new trick or fix you can use.

HARDWARE

CAN MY PC SUPPORT 4K?

I'm wondering if my Intel Core i3-6100 with onboard graphics is capable of running an Ultra HD monitor?

Dafydd Lewis

Most Intel Core processors from 2010 on support 4K displays – for basic usage at least. The Core i3-6100 has onboard Intel HD Graphics 530, which can display 4K images and play certain video formats, but will perform poorly when it comes to games. We contacted Dafydd to find out which motherboard was powering his PC – this is critical because the HDMI output may not support 4K at the recommended refresh rate of 60 Hz. Sure enough, his Asus Z170-A only supported 4K output via HDMI at 24Hz. Its DisplayPort connector does, however, support 60Hz, which means he needs to source a 4K monitor with a

DisplayPort input to ensure the best possible picture without having to invest in a dedicated graphics card.

Nick Peers

MAC

OUT OF DATE FIRMWARE

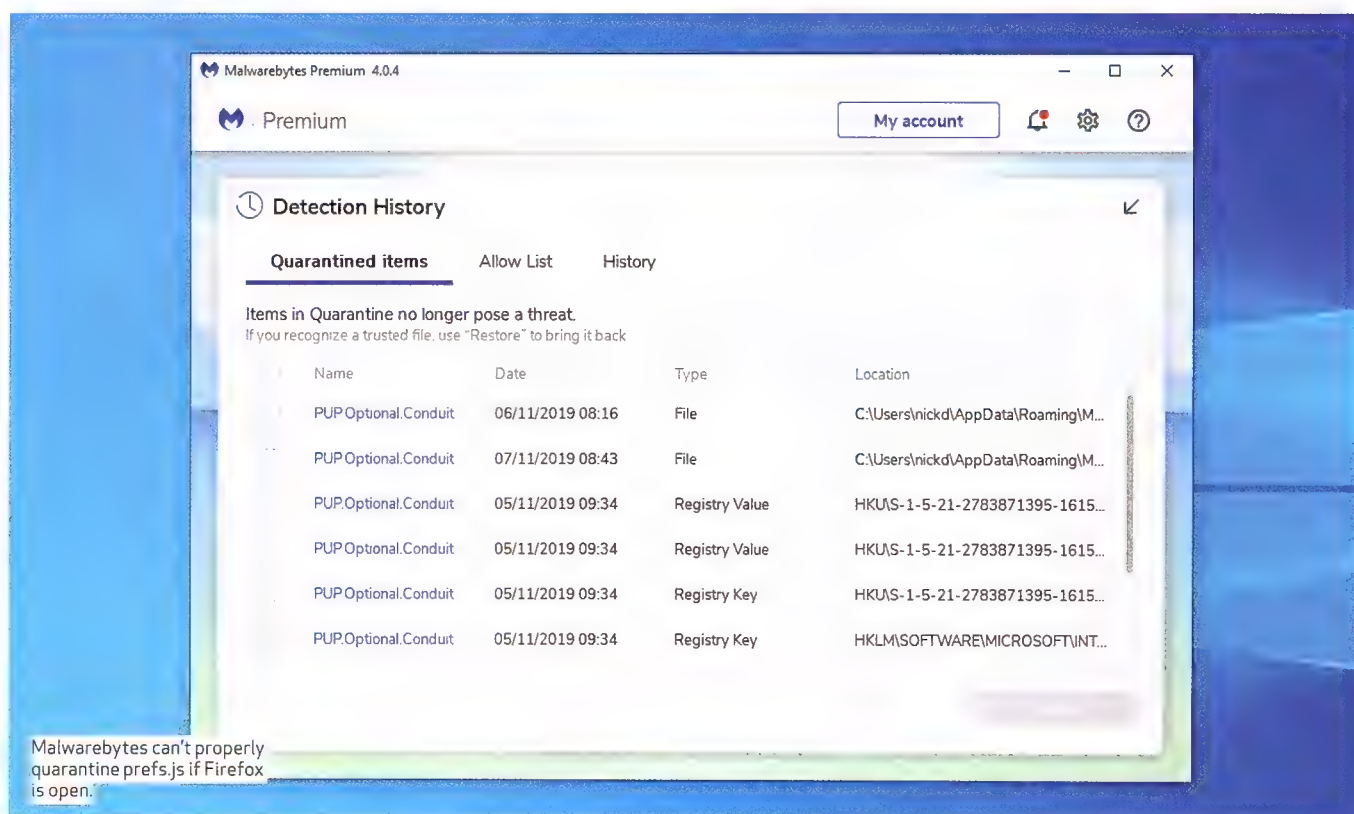
I replaced the internal Fusion Drive in my iMac with an SSD. It has now fallen behind with firmware updates. How can I bring it up to date?

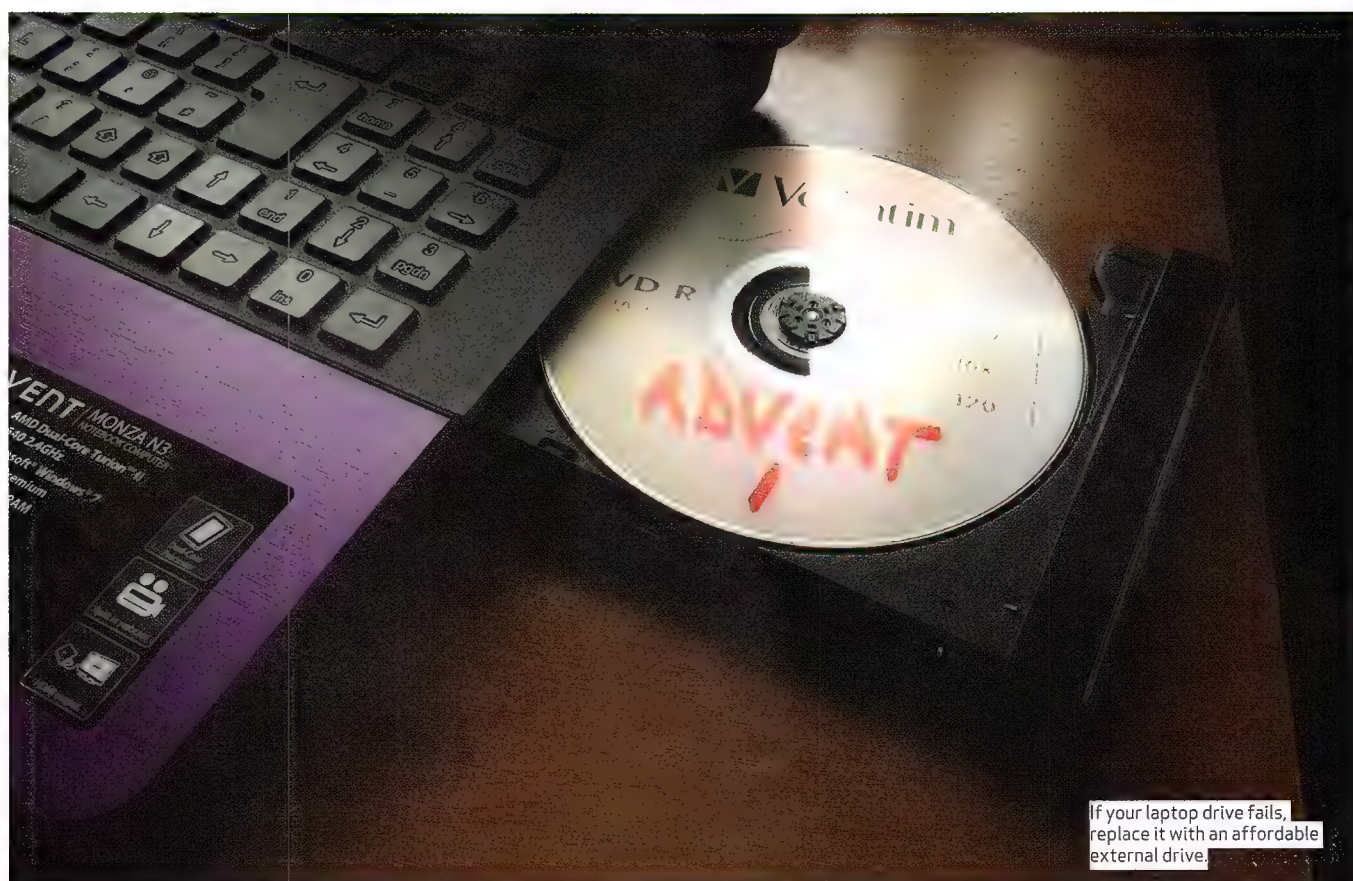
Ian Jamieson

Some years ago, Apple stopped supplying Mac firmware updates separately, and now delivers them inside macOS upgrades, updates, and security updates instead. For example, the macOS Mojave 10.14.1 update, High Sierra Security Update 2018-002 and Sierra Security Update 2018-005 all brought a set of firmware updates which also changed the numbering system for the firmware. Some Macs don't appear to install

these correctly, though, and one common feature to such problems is that the internal storage of that Mac has been replaced, normally with a non-Apple product, such as an original hard drive which has been upgraded to an SSD. One workaround is to replace the original storage in order to perform the update, but as 'firmware' is largely stored on disk that may not have any effect when the new storage is swapped back in. That also doesn't help if the original drive has failed, or been repurposed. Sometimes installing macOS from scratch as a clean install onto a freshly formatted disk can address this. In a few instances, the boot drive doesn't get properly formatted in the first place and may lack the Recovery or other partitions. Sorting these problems out gets very technical, and is probably best done by your nearest Apple store.

Howard Oakley





SECURITY

MALWAREBYTES VS FIREFOX PREFS FILE

Every time Malwarebytes 4.0 runs a scan on my PC it flags my Firefox prefs.js file as containing a PUP.Optional.Conduit. I presume this is linked to some add-on, but how can I find out which? And should I remove it?

Jonathan Glassier

PUP.Optional.Conduit refers to an online platform used to create custom toolbars and apps. It's known to change browser settings and display potentially dangerous adverts. However, it's not actually malware, so don't panic. Start by making sure that Firefox is closed before instructing Malwarebytes to quarantine the file – this will ensure the file is actually removed. Firefox will then recreate a new prefs.js file. If the file keeps getting flagged, you'll need to browse to your Firefox profile folder (press Win-R, type `%appdata%\Mozilla\Firefox\Profiles\` and hit Enter, then double-click the folder ending in '.default'). Right-click prefs.js and choose Edit to open it in Notepad to see if you can easily locate any suspicious-looking entries. If you can link them to a specific add-on (including any search engines you may have added), try removing it to see if that resolves the entry and resolves the problem – do so via `about:addons` (for extensions)

"If hardware failure is confirmed, then you have a choice: first, source a replacement drive for your specific laptop model."

and Options > Search (for search engines). If you can't find the culprit, but you're happy with your current setup, then PUP.Optional.Conduit is more an irritation than a genuine threat, so consider just ignoring it.

Carrie Marshall

HARDWARE

CDs AND DVDS ARE NOT DETECTED

For the past two months I've been unable to use CDs or DVDs in my laptop. I've tried different apps, but I always get the same error message: "Please insert a CD". I'm running the latest version of the Windows 10 Insider Preview.

Walter Tuschschmid

Sadly, this could well be hardware failure. Start by eliminating all other possible causes if you haven't already: run through the steps at <https://support.microsoft.com/kb/314060/> to verify it's not a driver or Windows-related issue. You could even go as far as to take a drive image of your current setup, then reinstall a retail copy of Windows 10 from scratch to see if the problem is resolved; either way, you can then roll back to your current Insider

installation. If hardware failure is confirmed, then you have a choice: first, source a replacement drive for your specific laptop model – you may need to search eBay, and track down your laptop's service manual online for the procedure to follow to replace an internal drive. An external replacement drive is an affordable alternative: around \$20-30 on eBay or Amazon. You may need two spare USB ports, one of which will supply power to the drive.

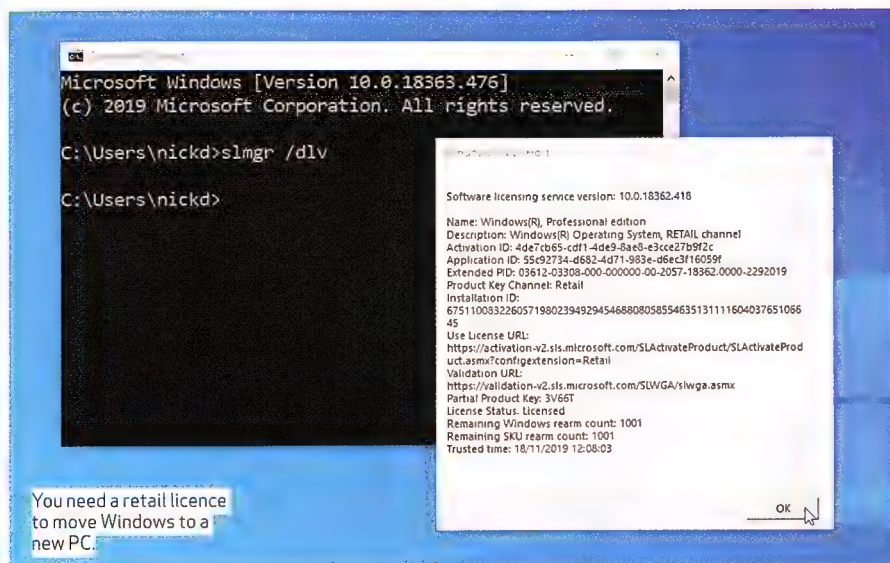
Ian Sleightholm

SECURITY

HAVE I BEEN COMPROMISED?

I received an email that concerns me. The subject line appears to list a password that contains some of the characters in the correct order that I've used, and then the email body is basically trying to extort money from me, claiming that I've visited an adult website and that my webcam recorded me 'having fun'. I'm being asked to pay \$2,000 to avoid embarrassment. Given I've never visited this (or any adult site), I'm pretty sure it's a scam, but those password characters worry me.

David Hargeaves



your copy of Windows to the PC you upgraded on. That's not necessarily true: if your old copy of Windows 7 was a retail one (in other words, not an OEM licence, or pre-installed by your PC manufacturer) then you should be able to transfer it to your new PC. To verify this is the case, open a Command Prompt or Powershell window, then type the following and press Enter:

slmgr /dlv

After a short pause a pop-up window should appear – if the 'Product Key Channel' is listed as Retail you should be fine to reactivate it on your new PC. You may need to use the Activation troubleshooter ('Settings > Update & Security > Activation > Troubleshoot') to get things working – make sure you're signed into the same Microsoft Account on your new PC as you used on your old PC.

Ian Sleightholm

STORAGE

RATTLING DEAD HARD DRIVE

My three year-old external hard drive stopped working when my Mac showed a warning to back it up and reformat. It now makes a rattling sound when turned on and won't mount at all. What can I do to rescue its contents?

John Martin

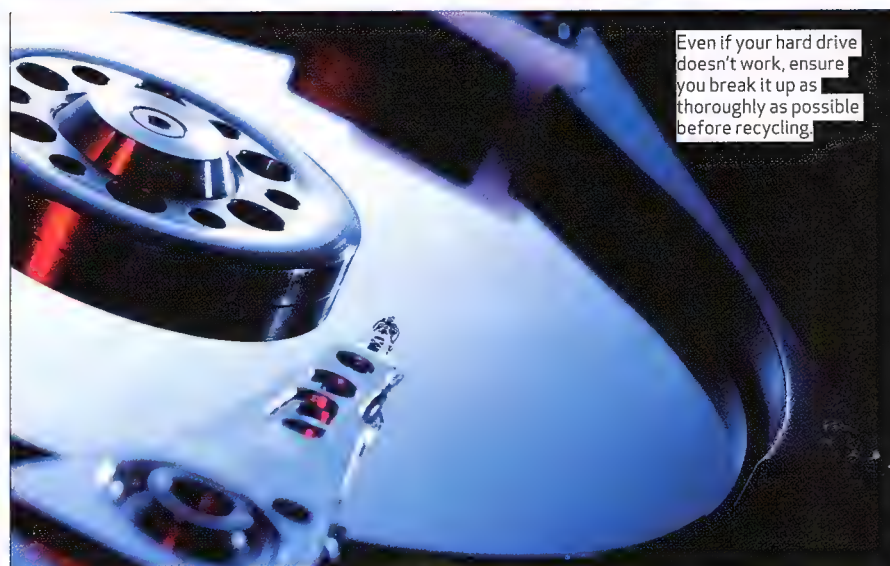
Sometimes, before a hard drive fails, you get sufficient warning to be able to rescue as much as you can from it before it packs up completely, as it will continue to mount on your Desktop. In your case, it seems to have suffered internal mechanical failure too rapidly to allow that. Avoid powering it up at all until you've decided what to do about this, as that could only make damage worse. Modern data recovery services can dismantle even badly failed hard drives in clean room facilities and mount their platters in special enclosures to recover data. However, this is very expensive and only likely to be worth your while if the files you have lost are very valuable. Typical costs are thousands of dollars, and there's a limited range of models which are suitable for such treatment. If you can't justify that cost, send the old hard drive for recycling. Before parting with it, even though it isn't working, break it open using a heavy hammer to ensure that no one else could try reading its contents.

Howard Oakley

OFFICE

UPGRADE NEEDED?

I'm currently running Windows 7 and Office 2010. I really don't fancy paying a monthly subscription for Office 365, so my question is: will I be able to continue



"You've been targeted because your email and some old passwords exist on a database containing old leaked passwords and emails."

The email is a complete scam, but there's some truth behind it. First, you've been targeted because your email and some old passwords exist on a database containing old leaked passwords and emails. The threat itself is empty, but it's a timely reminder to make sure you regularly update your passwords and avoid reusing the same ones. Use a free tool like LastPass (www.lastpass.com) to generate strong, random and unique passwords for your online accounts, and make the effort to update them every six months or so. Also consider employing two-factor authentication (2FA) for particularly

sensitive accounts – use Authy (www.authy.com) to enable you to supply 2FA codes from more than one device.

WINDOWS

ACTIVATE WINDOWS ON MY NEW PC

I'm looking to replace my old PC with a self-built model. I took advantage of the free upgrade to Windows 10 from Windows 7, but am trying to determine if I can transfer my Windows installation – a digital license – to this new PC from the old computer. Any help gratefully received.

Anita Rawlinson

There's a common misconception than when you accepted the free upgrade to Windows 10 you automatically tied

File Converter

name

☒ 18. Alfons Kontarsky, Aloys Kontarsky, Etc.; Karl Böhm: Vienna Philharmonic Orchestra - Saint-Saëns: Le Carnaval Des Ani...
☒ 07. Claudio Abbado: London Symphony Orchestra - Disc 1 of 2: Suite #1 - Allegretto
☒ 19. Clifford Benson, Shlo...
☒ 11. Fabrice Pierre, Patrick...
☒ 05. Friedrich Gulda; Clau...
☒ 17. Gidon Kremer, Oleg I...
☒ 08. Gidon Kremer; Claud...
☒ 20. Giuseppe Sinopoli: St...

status

Template Editor

Field Selector

Album

Album Artist

Artist

Composer

Disc-Track#

Genre

Title

Track#

Year

encode as:

MP3

encoding

Maximu

☐ output to the source file folder
☐ replace the source file - the original file will be deleted
☒ or to a new folder:

E:\Nick folders\Music\MP3\

☒ organise sub-folder and filename:

<Album Artist>\<Album>\<Disc-Track#> <Title>

☐ add converted files to the Inbox
☒ when the output file already exists, skip conversion and synchronise tag values only

play and skip count:

☒ reset to zero
☐ copy from source file

artwork:

☒ copy settings from source file
☐ always embed in converted file

☒ minimise to status bar when file conversion starts

Preview

Save

Output your converted files to a new folder to help organise and avoid confusion.

Proceed

Close

running Office 2010 when I upgrade to Windows 10?

The good news is that Office 2010 is the oldest version of Microsoft Office that's officially compatible with Windows 10 (Office 2007 should still run but is unsupported). If you're upgrading your current installation from Windows 7 to 10 then the program should be left in place when you update. If you're moving to a new PC, then we recommend uninstalling Office 2010 from your old PC before you install it on your new computer. Make sure you have your product key

handy – if you've mislaid it, use Lazesoft Windows Key Finder (www.lazesoft.com/lazesoft-windows-key-finder.html) before removing the software from your old PC to reveal it. Alternatively, you can buy Office Home & Business 2019 online, getting yourself an upgrade without the 365 subscription.

Catherine Ellis

MEDIA

BULK CONVERT AUDIO FILES

I've been sent some music files in FLAC format. I'd like to convert these to MP3 if possible. What do you recommend?

Paula Redhill

Our go-to music management app (MusicBee – get it from <https://getmusicbee.com>) is the perfect tool for the job. Here's what you need to do to set it up to convert from FLAC (or just about any supported source format) to MP3.

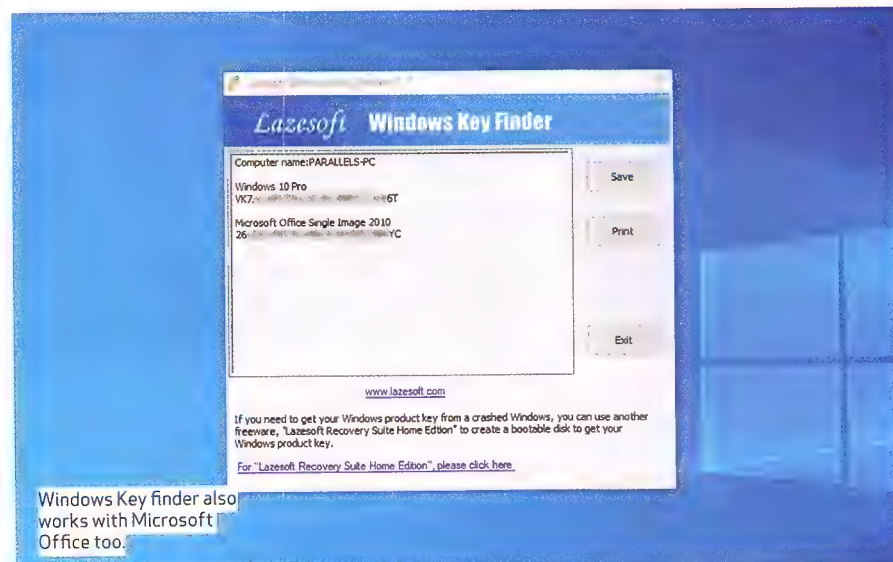
Open MusicBee and click the + button to open the file explorer pane on the left. Expand Computer and browse to the parent folder containing all your FLAC files. Once selected, all files within should be displayed in the main pane.

Click the word 'MusicBee' at the top to reveal its menu, then select Tools > Convert Format to open the file conversion tool. Verify all your files are in the top pane. Click the Encode as: dropdown to select your target file type.

You can output the copies to the same folders as the original, replace them or – our choice – select 'to a new folder', ticking 'organise sub-folder and filename' to ensure they remain organised and named correctly.

Tick 'minimise to status bar when file conversion starts' and click Proceed. The window will close, but you can monitor the file conversion progress from the main window's status bar. Once complete, check your files.

Catherine Ellis ■



Search better in Windows 10

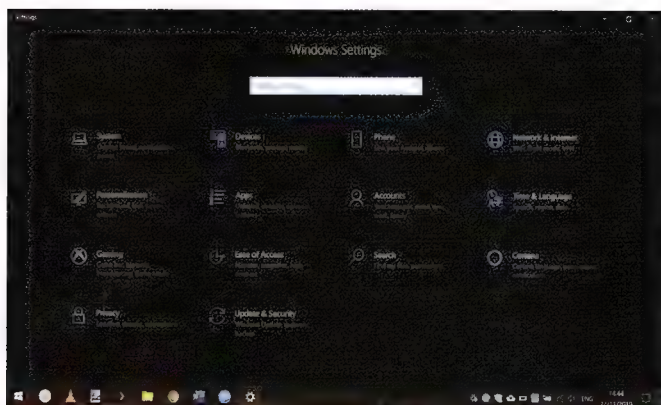
Windows 10's search tool can help you track down files, photos, emails and more – Mark Wycilik-Wilson shows how to get the best results.

Unless you are very organised, you have almost certainly mislaid the occasional file on your computer. Anyone who has spent time hunting through folders for a document will find things are a great deal easier if you turn to Windows' search tool, which is highly configurable.

Searching in Windows is actually very flexible, and you can save yourself a great deal of time and effort if you tailor the tool to suit your needs. You can even search the web with the very same tool. Here we take a look at the search options that are available to you, revealing the

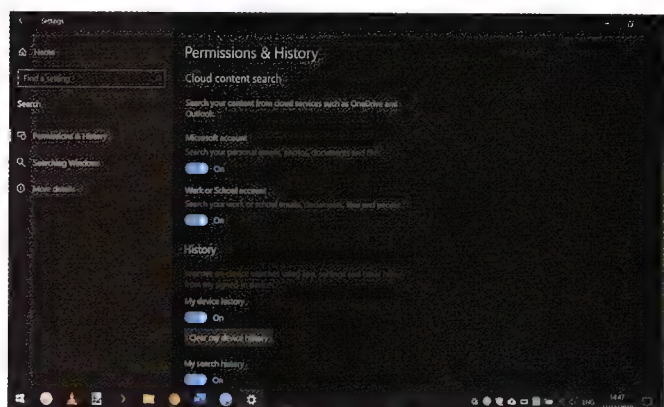
secrets that will help you to get the most from this handy feature of Windows 10. When we're through, you'll be able to perform advanced searches, and find what you're looking for faster than ever before.

All about Windows 10 searching



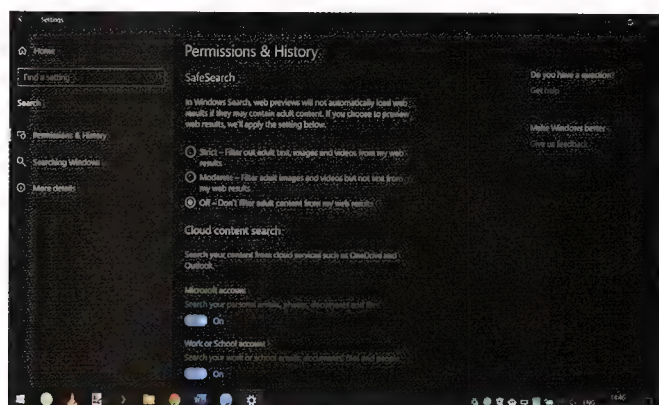
1 ACCESS SEARCH OPTIONS

Assuming you have upgraded your computer to at least Windows 10 May 2019 Update – and by now you really should have done so – you will find that within Settings there is a section for configuring Search options. Click the Start button followed by Settings, and then click the Search icon to start choosing the options you would like to put in place for your searches.



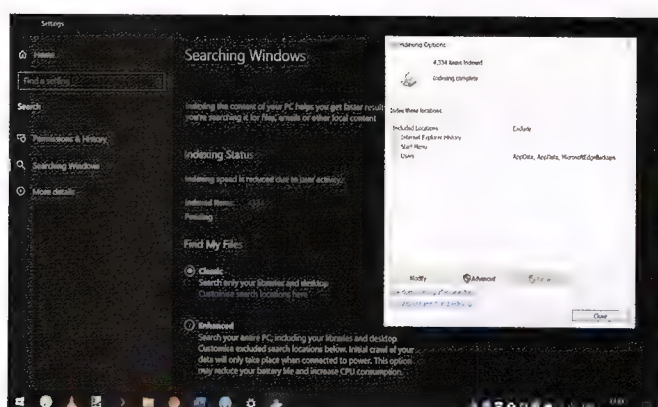
3 ADDITIONAL SEARCH SETTINGS

While you are in that section of search settings, scroll down a little further. By enabling the Microsoft Account setting, the search tool can look for content in your Outlook emails and OneDrive documents. It's also a good idea to enable My Device History and My Search History so Windows can learn from your searches and the way you use your PC to provide better results.



2 SAFESEARCH

Windows 10's search tool can be used to search the web as well as local files, and this means there is potential to be exposed to content you may not want to see. You can stop adult content from being previewed by enabling SafeSearch. If you opt for Moderate filtering, Windows will filter videos and pictures. If you choose the Strict setting, text will also be subject to filtering.



4 INDEXING OPTIONS

Windows indexes files in key locations so it can deliver results faster, and you can customise this in the Searching Windows section. If you stick with the Classic indexing setting, it is worth adding all the folders you store files in for indexing. Click Customise search locations here, then Modify, then tick the boxes next to all of the folders you would like to include.

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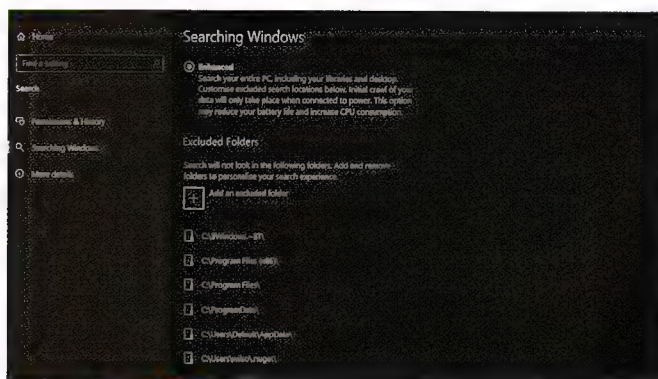
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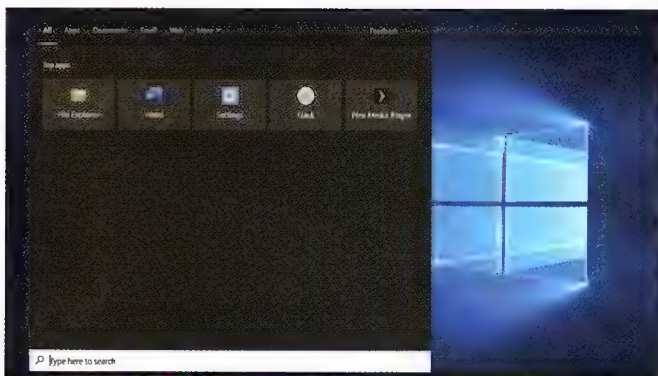
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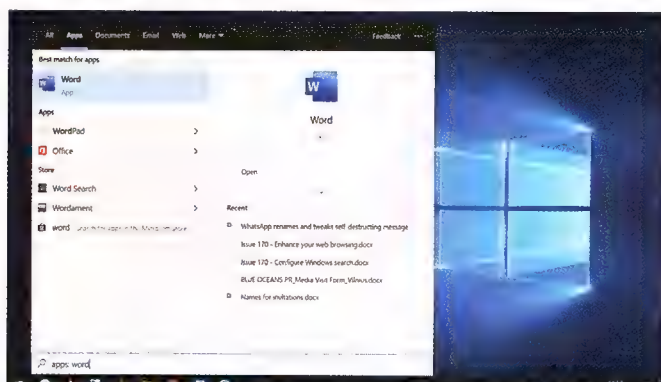
5 ENHANCED INDEXING

Alternatively, you can select Enhanced to index the entire contents of your computer. Now, you can choose to exclude certain folders from being indexed – just click 'Add an excluded folder' and select those you want to remove. You can also stop indexing certain types of file by clicking Advanced Search Indexer Settings followed by Advanced, and then deselecting file types.



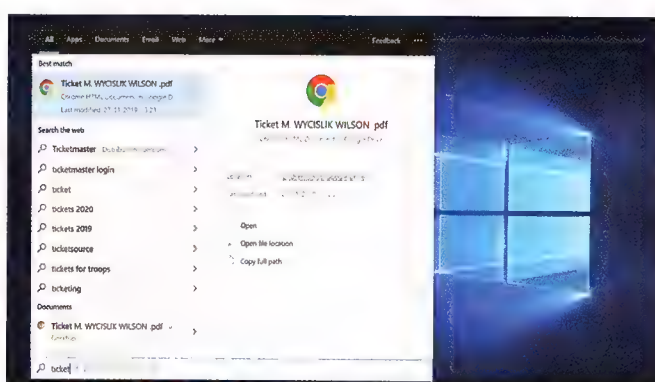
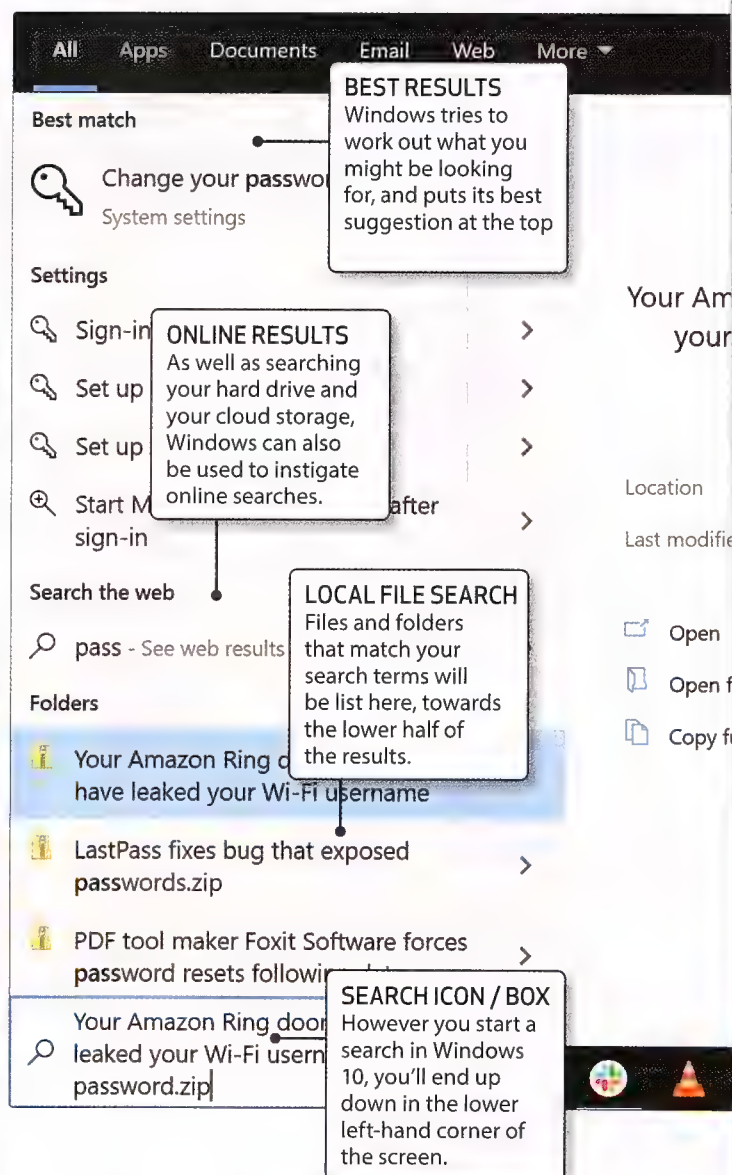
6 STARTING A SEARCH

To start a search, click in the Search box in the taskbar and start typing; if you have opted to display a search button instead of the box, click before typing. Alternatively, click the Start button or press the Win key and start to type your search term before pressing Enter, or press Win and S. All these methods produce the same result, so just use whichever works best for you.



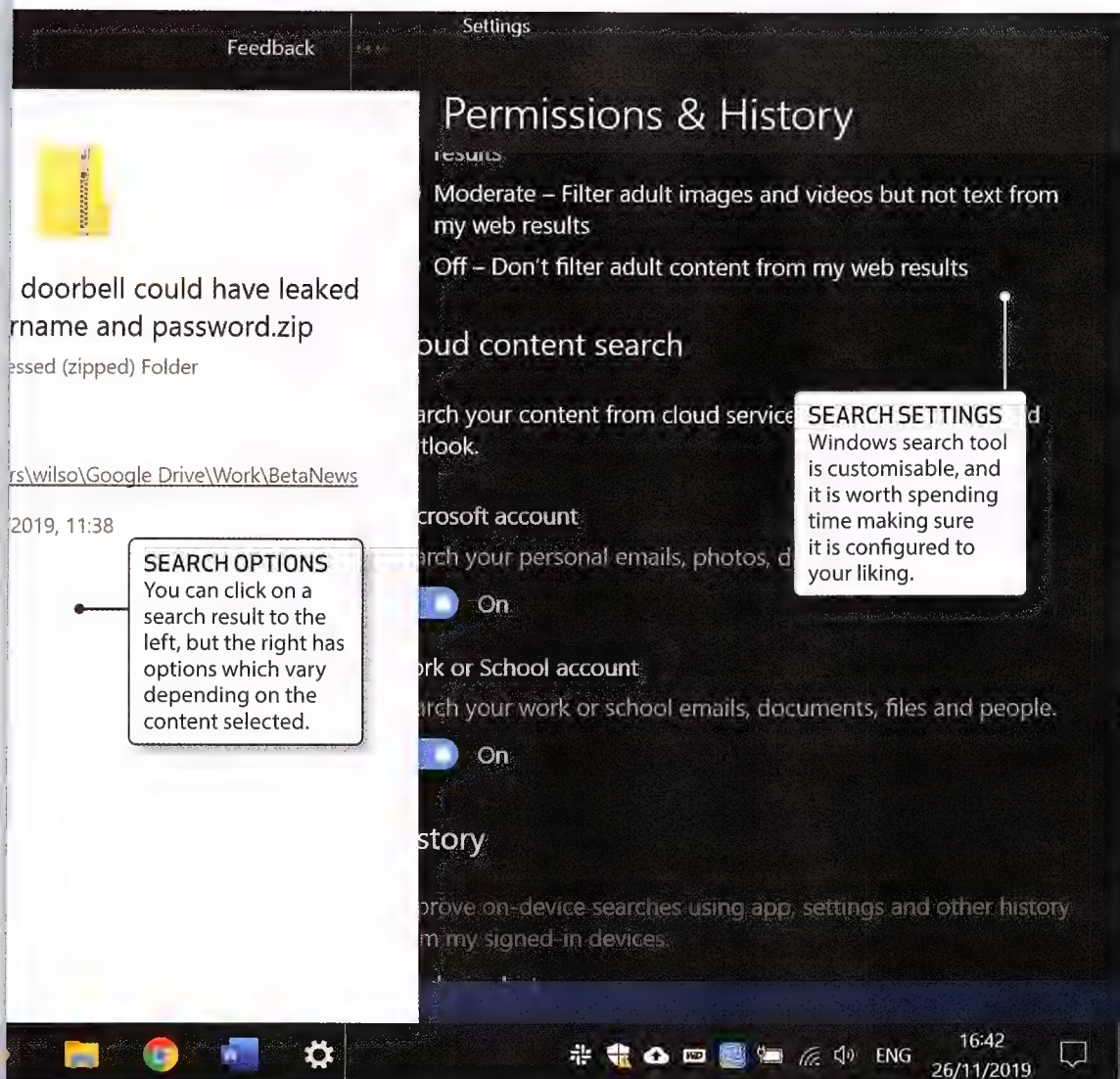
7 SEARCHING BY CATEGORY

You can make your searches more precise from the offset by searching by category. When you call up the search window you'll see a list of your top apps, as well as series of tabs labelled Apps, Documents, Email and so on. Click one of these tabs, and when you type your search term, the results will be limited to this type of content. So, if you're looking for an app, click the Apps tab.



8 GENERAL SEARCHES

You don't have to narrow the focus of a search, you can just call up the search window and start typing. Windows will try to determine what you are most likely to be looking for, and display a link to this in the Best Match section at the top. Beneath this you will see results for online searches that match your query, as well as documents found on your computer. Click a result to open it.



JARGON BUSTER

FILE INDEXING

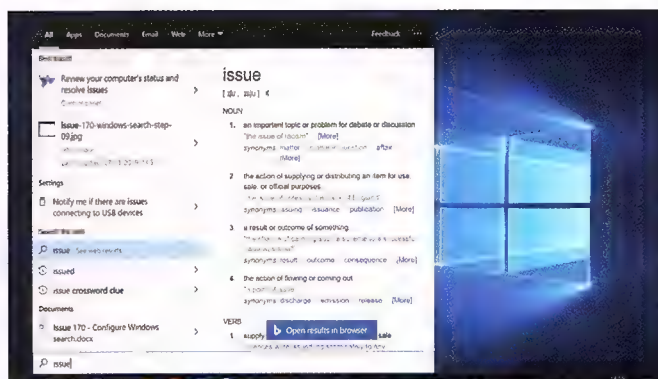
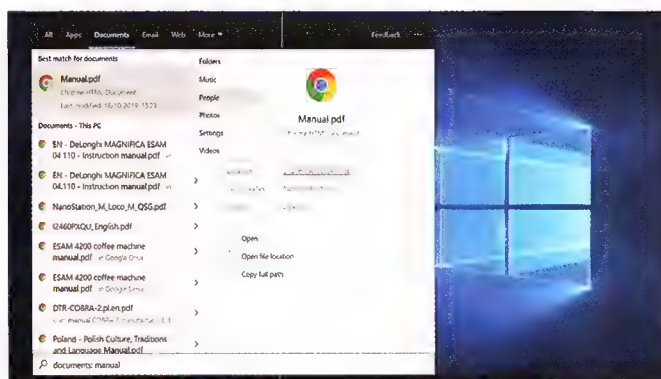
To help speed up searches, Windows indexes files so it has key information stored in a database that can be very quickly queried.

SAFESEARCH

A search filtering option that can be used to hide adult content from online results in Windows 10's search tool.

SEARCH BOX

An optional toolbar in Windows' taskbar, providing easy access to a search option without the need to specifically call it up.

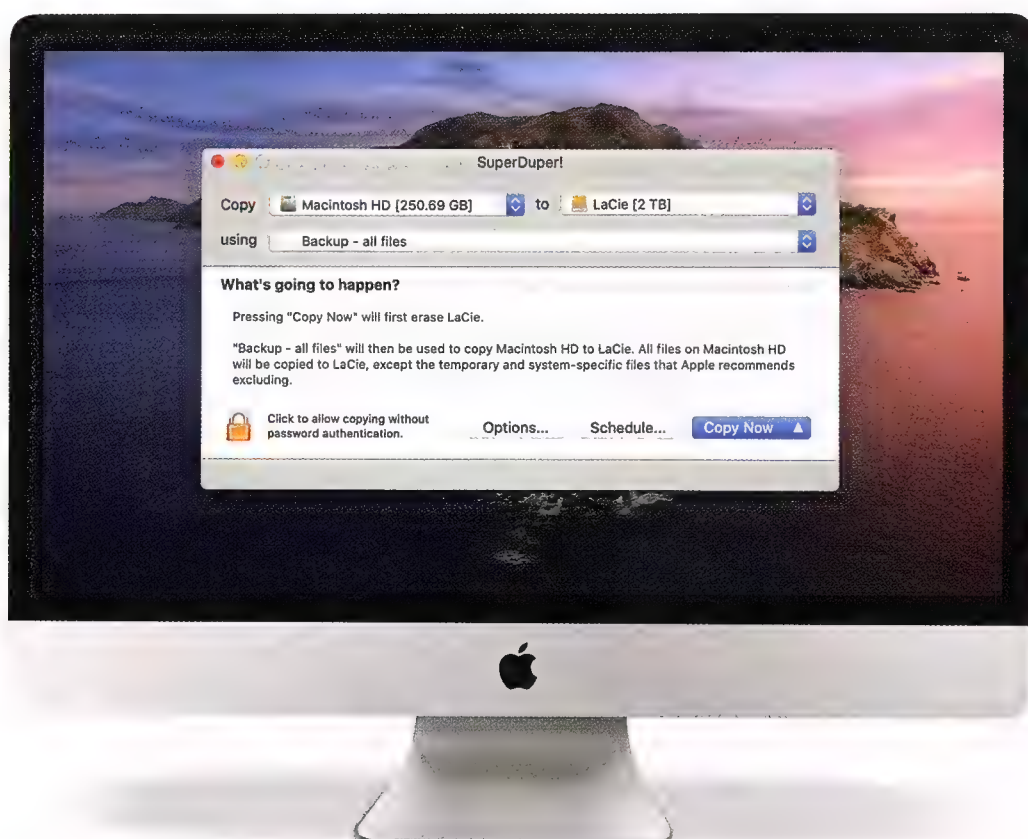


9 DEALING WITH SEARCH RESULTS

You can also filter results after your search is complete. When the search results appear, you can move to any of the tabs at the top, not forgetting the More tab which provides access to further filtering through a submenu. Using categories for filtering is very handy if you do not immediately find what you're looking for on the first screen.

10 SEARCH RESULT ACTIONS

You can interact with your search results by clicking the little arrow icon that appears next to them. In the case of web results, clicking the arrow will display a preview of the web page in the right hand section of the search window. If you click the arrow next to a file, you'll get options such as opening the files, copying its folder location, or opening its containing folder. ■



Create and restore a backup

Use SuperDuper to fine-tune and schedule your Mac backups.
With Cliff Joseph.

Apple's Time Machine is a good example of how the Mac is supposed to work. It takes a time-consuming tedious chore – performing regular backups of your important files – and just makes it work automatically, so that you can just plug

in your backup drive and forget all about it.

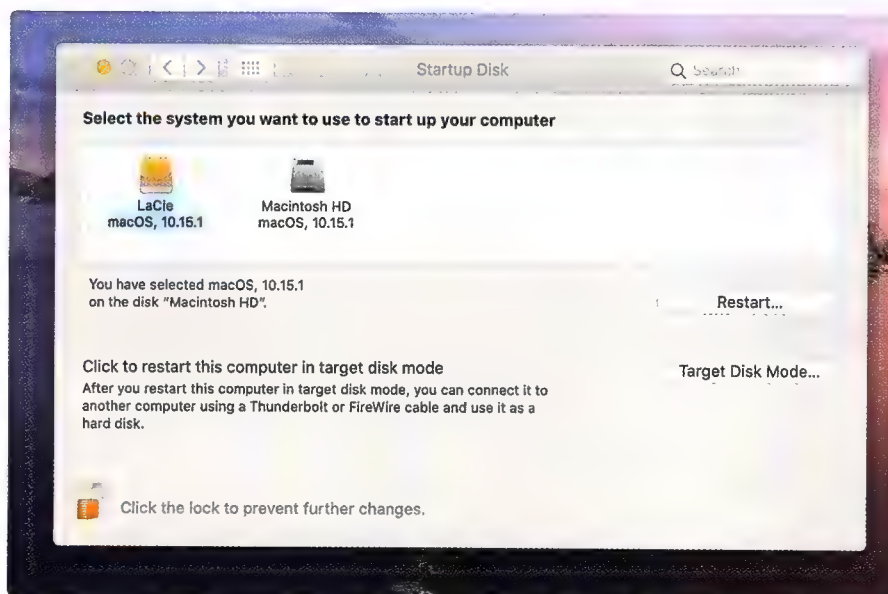
Time Machine does have some limitations, though. It automatically backs up files every hour during the day, and then saves daily and weekly backups going further back in time.

But it doesn't allow you to create your own schedule for backing up your files – such as a regular end-of-the-day backup for important work projects. And, while Time Machine can help to 'restore' your Mac if anything goes wrong, it doesn't allow you to 'boot' your Mac from your Time Machine backup drive in case your Mac's own internal drive develops a fault.

BACK AND BODY

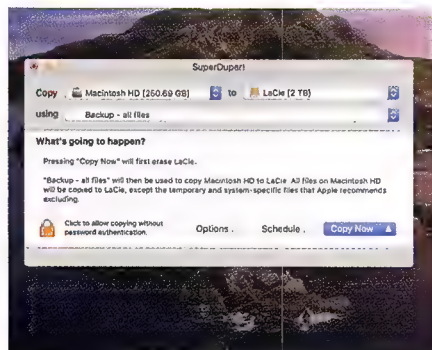
That's where other backup apps, such as SuperDuper, can come in really handy. The app is free to download, and provides basic backup options so that you can try it out and see if you like it before paying for the full version (US\$27.95).

It's worth paying the licence fee, though, for additional features such as the ability to create your own backup schedules. And, most importantly, SuperDuper allows you to boot your Mac from your backup drive, making it a really useful diagnostic and recovery tool in case anything goes seriously wrong with your Mac's hard drive.



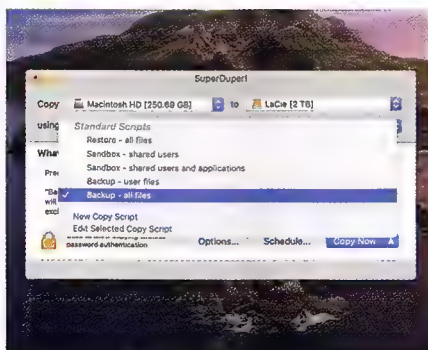
how to

Back up your Mac with SuperDuper



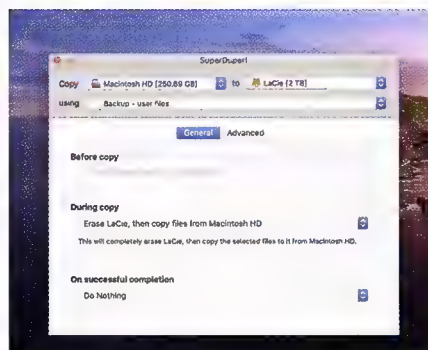
1 THE SOURCE IS WITH YOU

To set up your first backup, you need to select a 'source' and a 'destination'. The source is your Mac's hard drive, so select that in the 'Copy' menu. Here, the destination is an external LaCie drive, which we select in the 'To' menu.



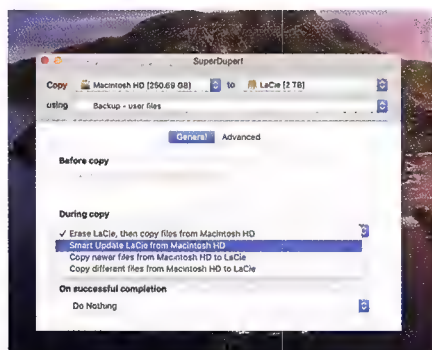
2 BACKUP BASICS

There are a number of backup options available. The main one is 'Backup - all files', which copies the entire macOS itself, and all your personal files. Alternatively, 'Backup - user files' just copies your Home folder.



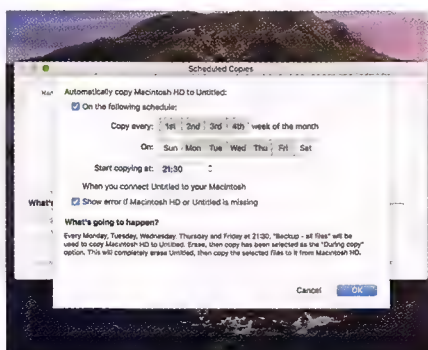
3 OTHER OPTIONS

You can click Options to fine-tune the backup process. By default, SuperDuper will erase your backup drive each time, and then make a completely new backup. That can take time though, so let's look at some other options.



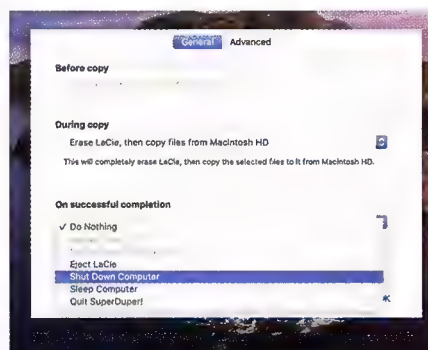
4 GET SMART

Click on the During Copy menu to modify the backup process. The best option here is Smart Update, which will keep your last backup, and only copy new files from your Mac, or remove files that have been deleted recently.



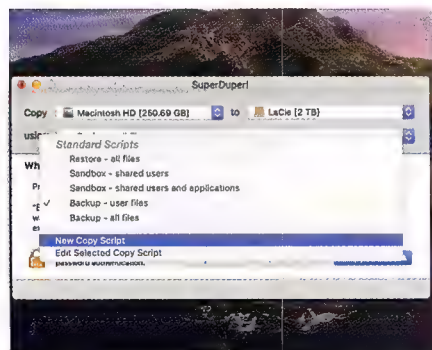
5 SCHEDULED BACKUPS

The free version of SuperDuper allows you to perform manual backups by clicking Copy Now. But it's worth buying SuperDuper for the ability to schedule automatic backups that repeat every day or every week.



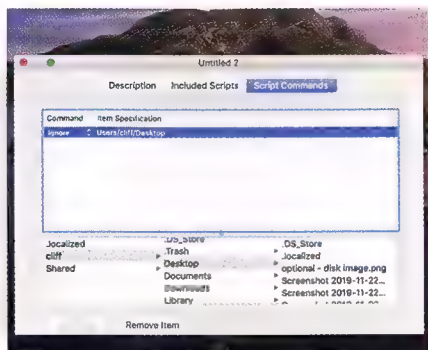
6 OVER AND OUT

You can also tell SuperDuper what to do when it's finished backing up. You can tell it to eject your backup drive, or to shut your Mac down automatically so that you don't have to wait around for the backup to finish.



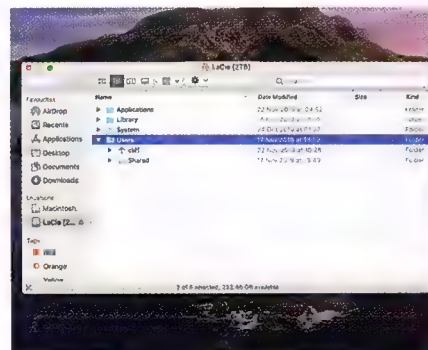
7 PICK AND CHOOSE

Like Time Machine, SuperDuper allows you to exclude individual files and folders from your backups. The program's interface gets a bit fiddly here, but you start by clicking the Using menu and then selecting New Copy Script.



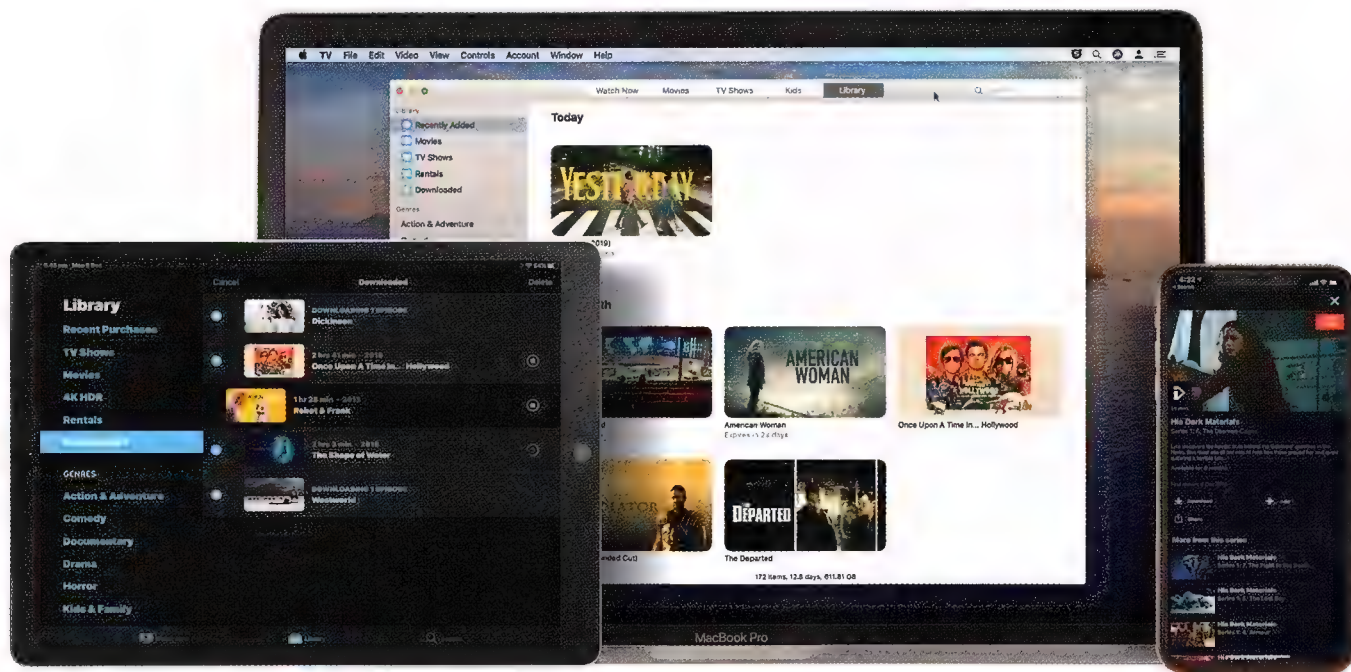
8 CUSTOM BACKUPS

The Script window enables you to locate files and folders, and then tell SuperDuper to 'ignore' them during the backup. You can also add files or folders to create custom backups that concentrate on a specific group of files.



9 FIND YOUR FILES

The backup on your external drive is an exact duplicate of the files and folders on your Mac, so if you delete any files by accident you can simply find them on the backup drive and copy them onto your Mac again.



View movies and TV offline

Rob Mead-Green shows how to enjoy your favourite films and TV programmes wherever you are.

There are thousands of movies and TV shows to enjoy in the Apple TV app on macOS, iOS and iPadOS. You can either buy or rent content from the iTunes Store, as you always have been able to do, access any previous purchases you've already made, and even enjoy the new shows available on Apple TV+, as long as you have bought an eligible device or subscribe to that service.

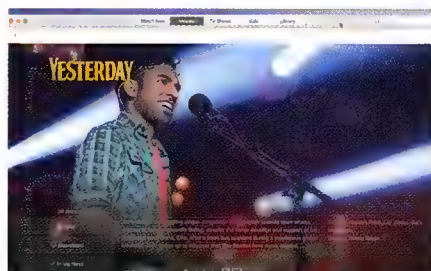
If you have a fast internet connection, you can normally stream content straight to your device – and this is still the only way to enjoy Ultra HD content on devices such as the Apple TV 4K. However, you can also download TV shows and movies for offline viewing, enabling you to keep watching even when you're away from home, and that includes Apple TV+

programming.

Here we'll explain how to download movies and TV shows for later viewing, how to identify what you've downloaded and how to remove shows you've already seen so you can free up space on your device.

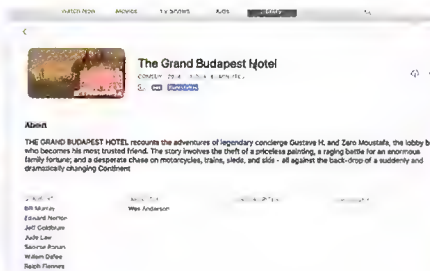
how to

Manage downloads on macOS



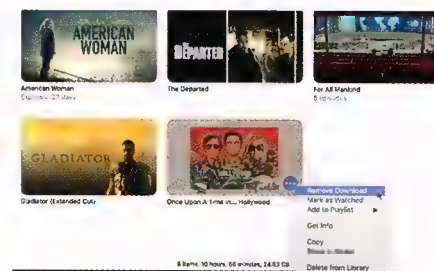
1 RENT OR BUY ON MAC

When you rent or buy something from iTunes, you're given the options to Play it or Download it. You can choose from SD, HD or HDR-quality versions (if available), depending on the choices you've made in TV > Preferences > Playback.



2 DOWNLOAD YOUR LIBRARY

You can also download any previous iTunes purchases you've made. Click the Library tab to see what's available. To download something, click its card, then the cloud icon with a downward-facing arrow to fetch it from the cloud.



3 MANAGE DOWNLOADS

Anything you've downloaded will appear in TV > Library > Downloads. Mouse over an item to reveal the Play and More (three dot) icons. To remove a download, click More and choose 'Remove download' from the menu.

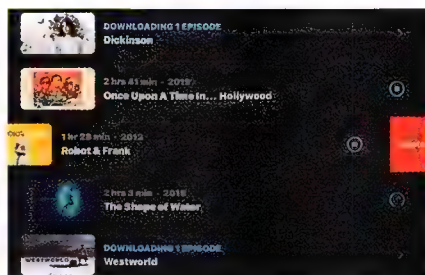
how to

Manage downloads on iPadOS



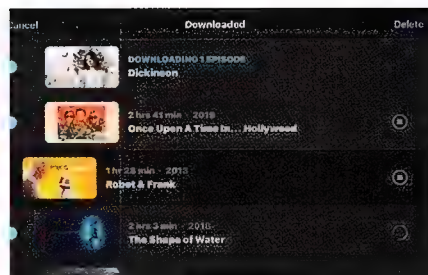
1 RENT OR BUY ON IPAD

Everything you've previously bought or rented on your Mac, iPad, iPhone or Apple TV should be available across all your devices, provided you're logged in to iTunes with the same Apple ID. We're about to download *Hala* here.



2 MANAGE DOWNLOADS

Anything you're downloading (or have previously downloaded) in the TV app will appear in Library > Downloaded. To watch a download, simply tap it to start playback. To delete a download, swipe left, then tap the red Delete button.

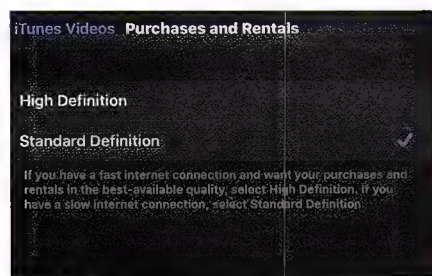


3 MORE DELETION OPTIONS

To delete multiple downloads at the same time, go to Library > Downloaded again, only this time tap Edit in the top-right corner. Next, tap on any items you want to select for deletion, then tap Delete in the top-right corner.

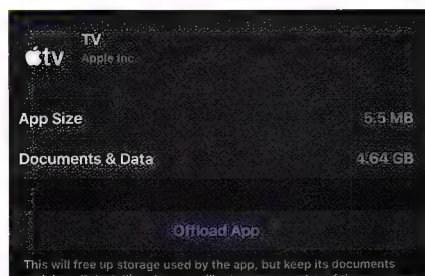
how to

Manage downloads on iOS



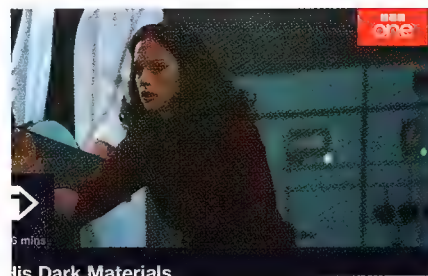
1 RENT OR BUY ON IPHONE

The process on iPhone is the same as on iPadOS above. To save storage space and make downloading faster, head to Settings > Apple TV > iTunes Videos > Purchases and Rentals and change the download quality to Standard Definition.



2 MANAGE DOWNLOADS

Again, you can see what you've downloaded to your iPhone at Apple TV > Library > Downloaded and can manage the content from there. Alternatively, head to Settings > iPhone Storage > Apple TV+ to delete any unwanted content.



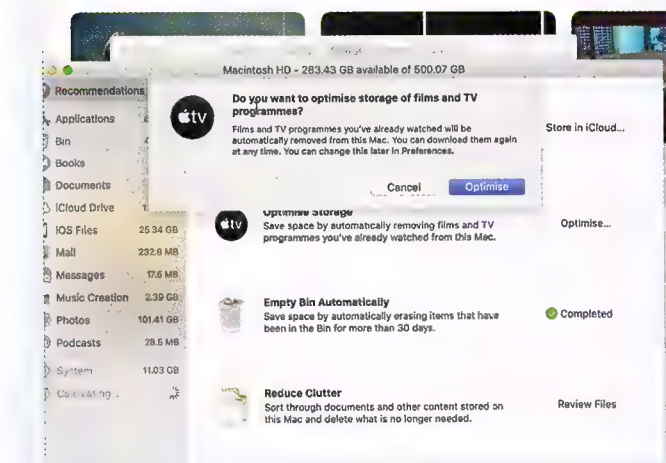
3 OTHER CONTENT

You're not limited to Apple TV+ and iTunes content, of course. While content from third parties will appear under Apple TV > Watch Now > What to Watch, you'll need to manage downloads from their specific apps.

Manage TV storage on Mac

Remove Apple TV downloads automatically.

One drawback of downloading Apple TV app content on Mac is that you can very quickly fill up the available space. To ensure that doesn't happen, head to **Apple > About This Mac** and click the Storage tab, then Manage. In the window that appears you'll see four options: Store in iCloud; Optimise Storage; Empty Bin Automatically; and Reduce Clutter. In the Optimise Storage section, click the Optimise button, then Optimise again in the pop-up window. Now any Apple TV downloads on your Mac will automatically be deleted once you've watched them. ■



Streaming from the command line

Shashank Sharma won't ever stop singing the praises of the command line, and applications like Musikcube, are the reason why.

Holidays are the time to get together with friends and family and share stories over some good food. It's an undeniable fact that such get-togethers are even better when complimented with music – major brownie points if you've got a streaming system in place. But if you want geek creds, you've got to be able to do all that from the command line.

Musikcube is a cross-platform music player. The native streaming ability sets Musikcube apart from other popular command-line music players such as Cmus. Although it isn't

available in the software repositories of many popular desktop distributions, the BSD-licensed project provides 64-bit binaries for the more-recent releases of Fedora and Ubuntu.

Unlike most other command-line utilities, Musikcube does have quite a few dependencies, but thankfully most of these are offered in the software repositories of most distributions. After downloading the pre-packaged binaries for your distribution, you can use the native package management utility to install Musikcube, and it will inform you of any missing dependencies. The project's wiki on GitHub has a list of distribution-specific dependencies and instructions on installing Musikcube from source.

USING THE PLAYER

The hardest part of working with Musikcube is getting its spelling right. Thankfully, the auto-complete feature on Bash means you will never encounter this difficulty. Besides, you can also create an alias to circumvent the curious spelling.

When you launch Musikcube, it drops you into the Settings view. The interface is split into three different panes. The pane at the bottom lists a

number of configurable options that define the app's behaviour. For instance, you can configure Musikcube's server settings, change key bindings, change the output device, etc. Take your time navigating through the different configurable options. You can tie Musikcube with your Last.fm account or change to a different colour theme. If the Check For Updates On Startup option is enabled, Musikcube will display a pop-up informing you of the availability of a new release.

In the top left is the file browser. You can use it to select your music directories. To add a directory to the library, select it in the file browser and then press the Spacebar. You can add multiple directories to the library, which are displayed in the indexed paths pane at the top of the interface. To delete a directory, select it from the Indexed Paths pane and press the Backspace key.

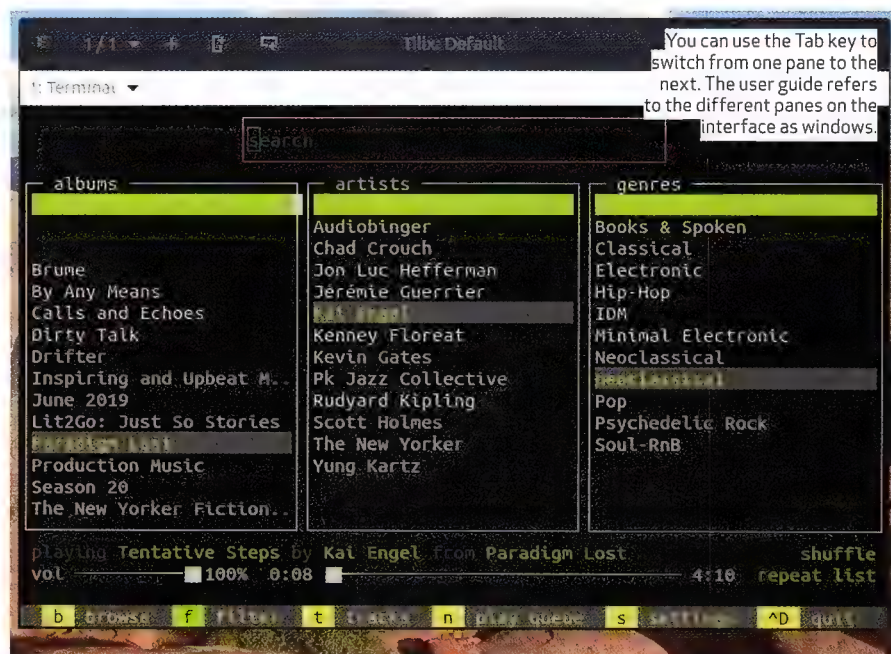
After you've added directories to the library, you must switch to the Library view from the default Settings view. To do this, press 'a'. Musikcube reads the metadata on the individual music files and can sort the collection according to genre, artist, album, etc. By default, the

Streaming with Musikdroid

Apart from the command-line music player, the project also produces an Android app called Musikdroid. This can be used as a remote control to manage the Musikcube player, or to stream music. First, head over to the Settings view on Musikcube and select Server Setup. The default ports should suffice for most users. Select the Audio Streaming Enabled option using the arrow keys and then press Spacebar. You should now see an X adjacent to this option. You can optionally set up a password for remote access. This is all the configuration that is needed to stream music to your Android devices.

Next, download the Musikdroid app from the project's releases page and install it on your Android phone. Once installed, you still need to configure the app. Open its Settings and enter the IP address of the host machine and password, if any.

The icon at the top right of the app's interface is used to toggle between streaming or remote control mode. In the latter mode, the actual playback occurs on the host machine, but you can select the track to play and otherwise control playback from your Android phone. In streaming mode, you can access and listen to your library on your phone.





You can redefine the key bindings from the Settings view by selecting the key bindings option from the bottom pane.

Library view features a pane on the left with a list of all the artists whose songs you have in the library. When you select an artist, the associated tracks are displayed in the Tracks pane on the right. If you have more than one album for an artist in your library, the Tracks pane will identify the different albums.

You can switch between the different panes with the Tab key. To play a track, select it from the Tracks pane and press enter. You can pause/resume playback of a track by pressing the Spacebar.

From the library view, accessed by pressing 'a', you can also toggle between different views. By default the Library view lets you browse your collection by different artists. You can alternatively press '2', to switch to the Albums view, where the pane on the left will display all the albums in your library. Press '3' if you want a view of all the different genres of the files in your library. You can also create different playlists with Musikcube and access these by pressing '5'. To return to the default Artists view, press '1'.

Like many other feature-rich command-line utilities, Musikcube has a vast number of default key bindings, but they don't perform the same function at all times. For instance, pressing the Spacebar in the Library view will pause or resume playback, but it does nothing when you're in the Settings view. Similarly, pressing 1-5 only works from the Library view and not the Settings view. In addition to view-specific and function-specific shortcuts, the project also has a number of default and global key bindings. As the name suggests, the global key bindings perform uniform functions, irrespective of where you

are in the Musikcube interface. You must refer to the user guide on the project's GitHub webpage for a complete list of configured key bindings (<https://github.com/clangen/musikcube/wiki/user-guide>).

On most Linux distributions and applications, the left Alt key on the keyboard is treated as the Meta key, and Musikcube is no exception. You can access the context menu for a selected item by pressing Alt+Enter. You can add individual tracks to a playlist by individually selecting them from your library, or you can create a playlist based on artist name or genre. From the Library view, press '1' or '3' to select either the Artist or the Genre view respectively. Select an artist or genre from the pane on the left. You'll notice that all the relevant tracks are displayed in the Tracks pane. Press Alt+Enter to access the context menu, and select Add To Playlist in the pop-up. You can choose to add to an existing playlist or create a new one. You can now access all the playlists by pressing '5' from the Library view.

The playback control bar appears at the bottom of the interface when you start playing a track. It has all the functions you expect from a music player, such as letting you tweak the volume, toggle shuffle on/off, queue repeat, etc. There are, of course, keyboard shortcuts to perform each of these functions too. The '/' key is used to toggle shuffle on/off. You can similarly use the '.' key to switch between repeat-list, repeat track, or turn off repeat.

FILTERING TRACKS

With an extensive music collection, you might not always remember the

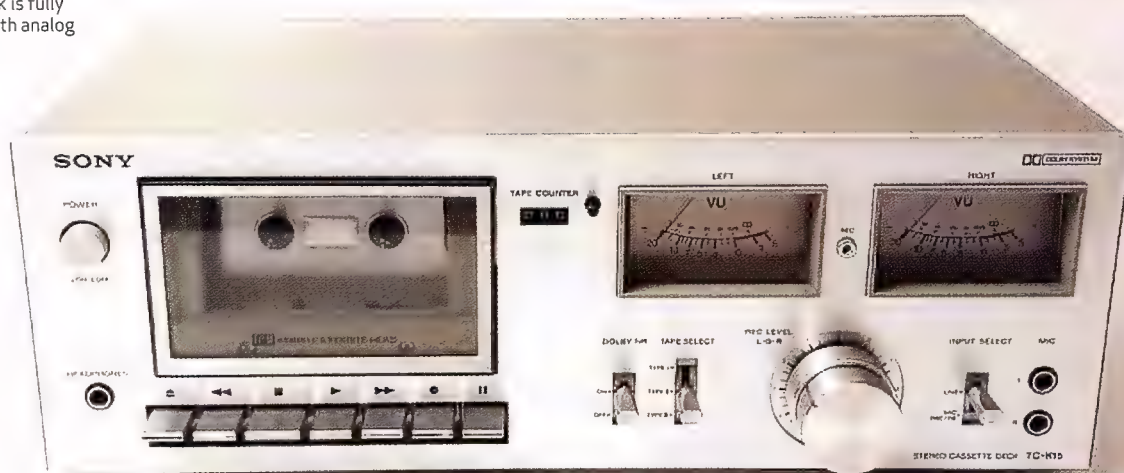
name of the artist or album, or even the complete name of the track you might be want to listen to. Should that happen, you can use Musikcube's filter function to quickly identify the track you're interested in. Press 'f' in the Library view to open the in-built search engine. There's a search bar at the top of the interface, while the panes at the top list all of the albums, artists and genres that your music collection features.

As you start typing in the search bar, Musikcube will narrow down the matching results for each category. For instance, when we type 'ch' in the search bar, it displays the album *Calls and Echoes*, the artist Chad Crouch and the genre Psychedelic Rock. The filter function, however, can't be used to narrow down a track you're interest in. For this, you must switch to the Tracks Filter view by pressing 't'. You can now use the search bar to identify all tracks that match your criteria.

Despite being a rounded utility, Musikcube does have a few shortcomings. For one, it doesn't support real-time or live updating of indexed paths. So if you add new tracks to an already indexed directory, an already running instance of Musikcube can't immediately see or access these tracks. You must either close and then relaunch Musikcube, or remove the directory and add it again. Also missing is support for internet radio stations. This is a fairly common feature in modern graphical music players, and it has already been requested by other users.

If you're looking for a robust music player to manage your collection of tracks, this nifty utility is more than up to the task. The ability to stream is icing on the cake. ■

My Sony TC-K15 cassette deck is fully old-school with analog VU meters.



Vinyl and mix-tapes direct to your phone

You don't need a PC or laptop to convert those soulful analog sounds into digital convenience. Darren Yates explains how to do it right on your Android phone.

Analog audio is back, people! Those sterile bland sounds of digital are out and glorious electro-mechanical tones of old-school analog tech are playing to a new generation. New-issue vinyl records are back in music stores and thanks to Marvel's *Guardians of the Galaxy* movie franchise, even audio cassettes are making a comeback (of-sorts). Still, we're willing to concede this new-fangled digital audio has some merit, particularly when you're stuck on public transport. So whether you're discovering 'sounds that spin' for the first time, or you're long from the old-school, this month, we're looking at how to copy that analog goodness straight to your Android phone – no PC or laptop required.

PART 1 – VINYL TO ANDROID

Rather than make this some sort of 'vinyl buyers' guide, we'll assume you're already kitted out with your vinyl setup and we'll stick to our knitting: getting that analog signal into your Android phone with the highest possible quality. Given I remember analog the first time around, I'll use a mix of old-school and new-school tech, so apart from a couple of items, you should be able to substitute and still have success.

The old-school tech is my vinyl collection and a Marantz TT2200

direct-drive turntable. The new-school gear is my 2019 Samsung Galaxy A30 smartphone and a Behringer UFO202 Phono/Line USB audio interface.

WHICH TURNTABLE GROUP?

Vinyl records consist of one long spiral-cut 'microgroove' that replicates stereo sound when you drag a special needle or 'stylus' through it. The vibrations of the stylus in that groove are converted into tiny electrical signals of roughly five millivolts (5mV). By contrast, CD players pump out up to two volts (2000mV) of signal. That '5mV' level is way too low to digitise, so this audio signal has to be made larger or 'amplified'. Not only that, the frequency response of audio recorded onto vinyl is altered or 'filtered' in a manner set by the Recording Industry Association of America (RIAA) to achieve longer recording times. That means we also have to 'invert' that frequency response to restore the original audio as it was meant to be heard.

The TT2200, like many turntables, provides nothing more than the signal output direct from the stylus and that's it. But don't consider that a bad thing – it means you get to choose the 'preamplifier' (or 'preamp' for short) the stylus output is connected to. However, many turntables (including new-gen

models) offer both options – the raw stylus output or an amplified output, thanks to a switchable built-in RIAA preamp.

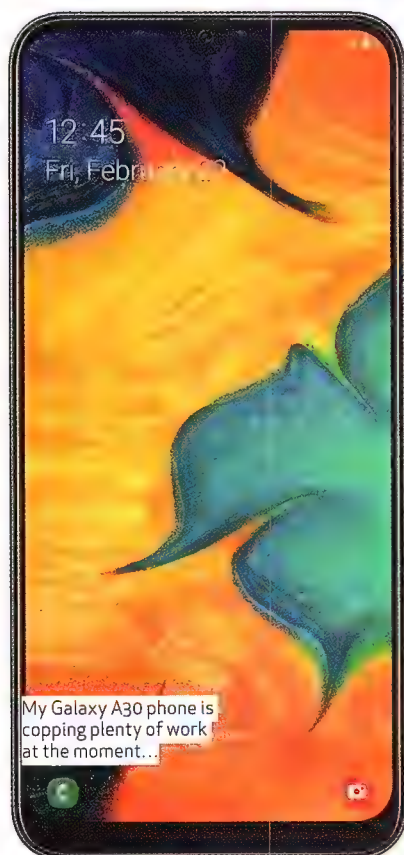
So to boil it down, if your turntable has a built-in RIAA preamp, you don't need to supply one, but if it doesn't, you do.

ANALOG-TO-DIGITAL INTERFACE

Android phones aren't set up for recording high-quality audio – at best, you might get built-in stereo microphones, but that's not the ideal



Audio-Technica's AT-LP60X, an entry-level turntable with some limitations.



way to capture this kind of audio. What we need is an analog-to-digital converter (ADC) that takes in and converts analog audio into a digital data stream your typical Android phone will have more luck with.

For this, we're using Behringer's UFO202 USB Audio Interface. It's low cost (about \$50 online), comes with stereo RCA inputs and outputs, plus a Type-A connector on the end of its USB cable. Now the UFO202 would normally plug into your PC or laptop, but we'll show you how to get it talking to your Android phone. The key reason for choosing the UFO202, however, is that it has a switchable RIAA preamp built-in, so regardless of the type of turntable you have, you'll have a way of capturing that analog sound.

WHAT YOU NEED

So let's bring together the gear you'll need:

Android phone with USB-OTG support - if you're not sure yours does, grab the free USB-OTG Checker app from Google Play (tip: any decent phone over \$150 should support OTG. Sub-\$150 phones? We're less confident).

USB-OTG adapter cable - this has a micro-USB or USB-C connector on one end (appropriate to your phone) and a Type-A USB port on the other.

Behringer UFO202 USB audio interface - as low as \$49 online from local retailers.

'USB Audio Recorder PRO' app from Google Play - this \$10 app remains the best option for turning an OTG phone into a high-performance digital audio recorder. It comes with USB Audio Class device driver support for a decent array of USB audio devices - including the UFO202. You can check the full support list at www.extreamsd.com/USBAudioRecorderPRO.

Turntable with analog outputs - just about any turntable will work, but some will sound better than others. Don't forget some vinyl to play!

Suitable analog audio cables - whatever you need to connect your analog player to your USB audio device.

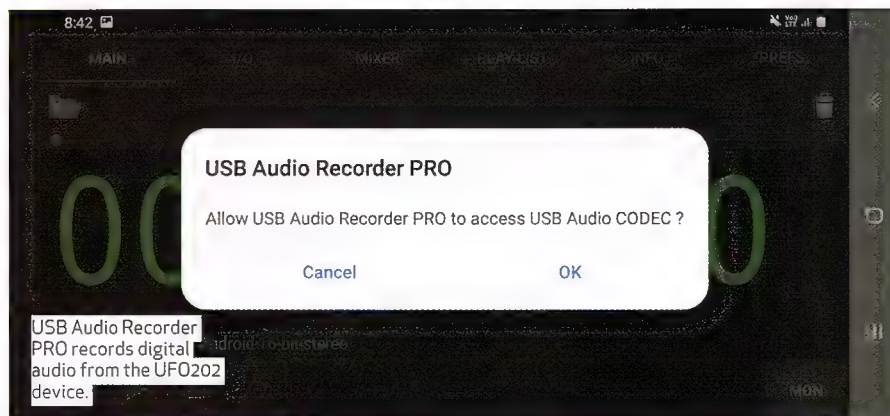
HOW TO SETUP

Install USB Audio Recorder PRO onto your phone, but don't launch it yet. Beyond that, the physical setup is pretty easy - first, plug the OTG



Tiny USB-OTG adapters like this can be troublesome through a phone case.

Older phones will need an OTG cable with a microUSB connector.



"The key point here is that for best results, you need to play back the tape using the same NR tech it was recorded with."

adapter cable into your Android phone, plug the UFO202's USB connector into the OTG adapter and finally, connect the turntable RCA outputs to the UFO202's RCA inputs. If your turntable has a ground-plane wire, you can connect it up to the ground post on the UFO202.

One thing to remember here – your phone powers the UFO202. On our testing, the UFO202 consumes roughly 50mA of current, so battery drain should only be modest. However, to be safe, start with at least a 75%-capacity phone battery. We'll record the vinyl LP in 44.1kHz/16-bit stereo, which means for each typical 30-minute-max vinyl LP 'side', you'll need roughly 320MB of storage space.

SETTING THE PREAMP

If your turntable has a built-in preamp, you've got two choices – use that one or the one in the UFO202. My preference would be to try each one in turn (never switch in more than one at once) and see which you like best. If you use the turntable preamp, set the switch on the UFO202 to 'line'. To use the UFO202's preamp, flick the switch to 'phono' and turn off your turntable's preamp. (Tip: if your turntable has a built-in preamp but you can't find the preamp switch, try lifting up the turntable mat and rotating the platter – sometimes, it's hidden under there). Now head to Part 3 to do some recording.

PART 2 - CASSETTE TO ANDROID

Getting your old mix-tapes onto

Android is a bit less complicated, since virtually all cassette decks, recorders and players output a line-level signal you can plug into the UFO202 set to 'line'. At this point, though, you don't need to specifically use a UFO202. Any stereo line-level USB audio device supported by USB Audio Recorder PRO will do.

If you're using a portable cassette player and the UFO202, you'll probably need a 3.5mm-stereo to RCA-stereo cable. These sell for about \$5 online. Otherwise, other supported USB audio interfaces will likely have a 3.5mm stereo line-input, requiring a 3.5mm to 3.5mm stereo cable instead (about the same price). You'll quickly discover analog audio is easier to route than digital audio.

NOISE-REDUCTION SETTINGS

Compact Disc essentially came about to overcome the lack of dynamic range available in vinyl and tape, but before its arrival, various noise-reduction (NR) techniques were invented to improve the dynamic range of recordable tape.

Dolby is the name behind today's Atmos multi-channel surround-sound framework, but it began life developing noise reduction (NR) circuitry for tape recorders. Dolby-B arrived in consumer decks in the early-1970s, Dolby-C in 1981 and Dolby-S on select high-end cassette decks in the late-80s. But Dolby wasn't the only option – personally, I prefer the less-common 'dbx', but JVC also had ANRS and other brands used High Com.

The key point here is that for best results, you need to play back the tape using the same NR tech it was recorded with. If you don't, you'll end up with poor-sounding recordings – either 'bright' and 'hissy' in the case of Dolby,





or 'breathy' for dbx. Most commercial tapes were recorded for Dolby-B use (find the double-D logo on the cassette's J-card).

If you forgot to write down on your mix-tapes which noise-reduction you used, start playback with no NR and cycle through your available options to work out which one sounds right to you.

PART 3 - RECORDING TO ANDROID

Now that we've got the analog side sorted, we can start capturing the audio into USB Audio Recorder PRO.

With all the bits connected, fire up the app. You should've seen a permission-request to access the UFO202 with USB Audio Recorder PRO - tap OK. When the app appears, you'll see the 'tape transport' buttons on the lower left and a menu across the top. Just above those tape-transport buttons is a summary of your device storage, plus input and output settings. If you don't see '44100, 16-bit' and 'STEREO' for the input and output, tap on the 'I/O' menu option and adjust the settings.

When that's done, tap the 'mixer' menu option to bring up the audio level controls. Here, you just need to ensure the 'mute' button is off and the left and right level controls are both fully up. Now tap the 'main' menu option to go back to the main screen.

TEST RUN

Assuming you've done the usual cleaning checks, cue up your vinyl (or tape) to the loudest section on that side, tap the 'MON' (monitor) button on USB Audio Recorder PRO and start playback. At this point, you're just checking that the recording levels on the app's peak level meters aren't slamming the end-stops. If they are, use the level sliders on the 'mixer' screen to drop the level until it stops. Now you're ready to cue up the start, tap the round-circle 'record' button on the app, start play and record that side. You can cut up individual tracks as you go, but it's easier to do that later and just record the full side as one to start with (Lexis Audio Editor is free and great for track-slicing).

THE RESULTS

The TT2200 turntable has a moving-magnet (MM) cartridge and even with USB Audio Recorder PRO's recording levels set to 'flat-stick', the recorded audio from the UFO202 peaked at -4dBFS (4dB below the top '0dB' mark). I also tested the UFO202 by feeding the TT2200 into the phono input of my Marantz PM25 integrated amplifier and taking the 'monitor' output to the UFO202 switched to 'line' input. Personally, I preferred this second setup rather than the 'TT2200 to UFO202' option - the bass was more solid.

The UFO202 was fine for recording

my Dolby-B mix-tapes, since Dolby-B tapes do no more than 65dB signal-to-noise ratio (SNR) and the UFO202 has a line-level noise floor of about 78dB.

Ideally, your USB audio interface should have a noise-floor lower than your source material, which in this example, the UFO202 does.

However, tapes recorded with dbx can have a dynamic range of over 90dB, which means the UFO202 won't cut it and you'll need a higher-end audio interface with better SNR to do the job. Now that said, if you're listening to the results on a train, it's unlikely you'll hear the difference between 78 and 90dB. In the end, it comes down to a question of how far you're prepared to go for perfection. A Kia Cerato will get you to work just as fast in traffic as a Ferrari F50 - although, clearly, one will be more enjoyable.

TROUBLESHOOTING

The only problem we had was trying to plug in a third-party USB-C OTG adapter into the Galaxy A30's USB-C port through a cheap phone cover. The adapter didn't quite fit it and bumping it caused the phone to instantly turn off and lock up. The fix (apart from not using a crappy phone cover in the first place) was to reboot the phone by plugging in the charger via the original USB-C power cable and powering up the phone. The moral of the story? Make sure the connectors all fit properly! If you're worried, use an old phone.

GETTING THE BEST QUALITY

Behringer's UFO202 is by no means the only option here. If you have a separate RIAA preamp and a high-quality USB audio device supported by USB Audio Recorder PRO, there's no reason it shouldn't work. The key thing is that provided your Android device supports USB-OTG, it won't matter whether you have a Galaxy S20 or a cheap pre-paid 'special'. Apart from providing power to a bus-powered USB audio device, the phone simply captures the digital stream of audio data - the audio quality has already been set by the USB audio device, so keep that in mind when troubleshooting.

Personally, I think you need to spend at least \$400 to get a decent new turntable with good features, like low wow-and-flutter, adjustable tonearm tracking force and replaceable cartridges. I'm also allergic to turntables with handles (call me a snob).

But that's the thing about audio - if you're happy with it, it's good enough. Strapping a turntable to your back isn't practical for the daily commute, but you can still listen to your vinyl on your phone - and now you know how to without needing a PC or laptop. ■

Receive and process global radio signals

Sean Conway provides instructions on software-defined radio (SDR) that turns your Raspberry Pi into a FM radio receiver.

You need

Hardware

- Raspberry Pi 3B+
- 16GB micro SD card
- 5VDC 2.5 amp power supply USB micro

Software

- Latest Raspbian Buster full
- rtl-sdr 0.6-1
- gqrx 2.11.5
- cubicSDR 0.2.5

This tutorial is designed to explore software-defined radio (SDR). We will cover some radio frequency (RF) theory in order to have a foundation for the article. The goal is to configure an SDR USB dongle, for this tutorial on a Pi, to receive a broadcasted FM radio signal.

SDR is a radio frequency communications system built using software, rather than physical hardware circuits consisting of oscillators, filters, modulators/demodulators and signal amplifiers, to transmit or receive a radio frequency broadcast signal.

SDR devices receive analogue radio signals through an antenna, and then using an analogue-to-digital converter (ADC) they digitise the signal that can be further processed using digital signal processing.

WHAT IS IN AN RF BROADCAST?

An RF broadcast is a transmitted carrier signal travelling through the air. The signal is encoded with information using a modulation method. Two common RF modulation methods are frequency modulation (FM) and amplitude modulation (AM). In FM the carrier signal frequency is up-shifted and down-shifted in carrier frequency relative to the data applied. In AM the carrier signal amplitude varies according to the data applied.

To extract the data from the RF signal you would require a receiver that matches the modulation technique the signal was broadcasted with. The receiver has specific electronic circuits to process the modulated signal. The signal is gathered at the antenna and sent through the receiver circuit to extract the data and produce an output.

The block diagram (see top right) presents a pictorial of the electronic circuits needed to provide the functions required inside the AM and FM radios to produce the data. SDR replaces a majority of the hardware by performing the bulk of the circuit-heavy lifting in software. It also has the advantage of performing this processing over a larger frequency range than typical radio receivers.

With an antenna and an SDR dongle, radio signals can be gathered via the



antenna, digitised by the dongle and processed using software on the Pi to produce the data that was carried on the modulated carrier signal. There are SDR dongles that can be both an RF transmitter and/or an RF receiver. These devices are referred to as SDR transceivers. For this tutorial we will use a SDR dongle that is a receiver only – no transmit. The objective is to extract the audio signal in an over-the-air FM-broadcasted signal.

WHAT IS SDR GOOD FOR?

With an antenna and the SDR dongle the sky is the limit. There are different frequency ranges of RF signals. If the antenna is tuned to the receive frequency and the SDR is designed to operate in the same frequency range, then the signal can be processed.

The software on the computer must then have the capability of demodulating the signal and possibly decoding the signal. Decoding suggests the signal was encrypted and would need to be decrypted to be usable.

Here's a short list of RF signals and the data that can be extracted using an inexpensive SDR device:

Quick tip

Go to www.rtl-sdr.com/RTL-SDR for the software-defined radio news and info.

- AM/FM radio stations
- Aviation communications (conversations between aircraft and air traffic control)
- Ham radio (person-to-person conversations)
- Aircraft Automatic Dependent Surveillance-Broadcasts (aircraft positions)
- Satellite transmissions (weather data)
- There is even a suggestions of recording vehicle keyless entry broadcasts and then playing them back.

This tutorial is intended for educational purposes. In most countries it is legal to receive broadcast RF signals, but in some countries this activity may be illegal: it is your responsibility to be aware of any legal restrictions in your region.

Quick tip

You'll find a list of RTL-SDR supported software here: www.rtl-sdr.com/big-list-rtl-sdr-supported-software.

HOW DOES SDR WORK?

Broadcasted RF signals that are gathered by the antenna are converted to lower frequencies found in the audio band with the compact electronics in the SDR dongle. The frequency is then sampled using high-performance analogue-to-digital converters (ADC) to produce a digital output.

To paraphrase Nyquist's theorem: an analogue signal can be reconstructed if samples are taken at equal time intervals. The sample rate must be equal to or greater than the highest frequency being sampled. The ADC used in SDRs have sample rates typically in the 200kHz range – plenty to ensure an error-free reproduction.

We've chosen to ignore nearly all of the concepts and complex maths associated with the operation of an SDR device. Quadrature phase modulation theory used to bend vectors 90 degrees at 0Hz is way beyond this writer's understanding, let alone explaining it effectively.

WHAT IS NEEDED FOR SDR?

The puzzle pieces required to assemble an SDR receiver can be divided into three categories: the SDR device itself; the antenna for receiving signals; and the software, along with the PC it will run on. Components from all three categories work together to produce an output. Reducing the performance of any one of these components will impact a successful SDR project. You can have a smoking-hot performance from the SDR dongle, but if the antenna doesn't produce enough input signal, the SDR may only produce the sound of static noise.

There is a balancing act in the form of cost verses performance, especially for the novice with little money who wants to dabble in SDR. Given sufficient money, all three categories could be optimised to achieve the best performance. For the basement technology geek in most of us, unlimited cost is not realistic. Our Quick Tips provide some resources to help you decide what components from the categories fit your budget.

Two dongles were used to develop this tutorial. The price point of each was different. As much as we'd like to purchase a higher-end SDR unit, clearer heads had to prevail and only invest in purchases that were needed to provide

a comparison to complete the article.

In addition to the price of the two SDRs being different, so was their performance. The cheaper SDR dongle didn't appear to work initially. After successfully getting the more expensive SDR device working, we doubled back using the knowledge gained to optimise the software configuration, enabling audio to be produced from the economical unit.

SDR receivers or SDR transceivers are designed to span a specific frequency range. An SDR will have a specification for the frequency range the device is capable of handling. The range can be from low frequencies in the kHz to frequencies in the GHz or thousands of MHz range.

Devices like SDRs that are capable of transmitting and receiving RF signal require an antenna to handle the modulated signal. The diagram on the last page of this feature shows an ideal vertical dipole antenna radiation pattern. The RF source sends a signal to the antenna and it is radiated out in a torus or doughnut pattern. The RF signal energy is equal in all directions.

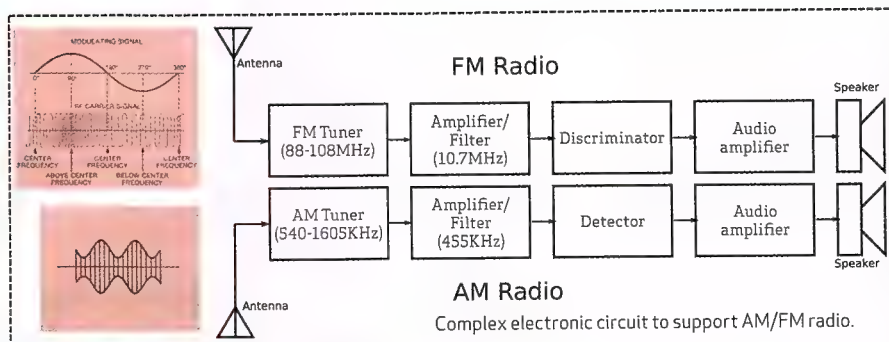
Antennas are designed to provide the best performance at a given frequency or range. The physical construction of the antenna and the components used determine the performance of the antenna. Antennas can be designed to increase signal strength in one direction with a reduction of the signal strength in other directions. These

antennas are directional.

The RF energy is focused in one direction with very little escaping out the back. This type of antenna design enables greater range in the direction the antenna is pointed. If the signal is coming from the back side of the antenna, performance is degraded.

At lower-frequency ranges the antenna length is longer, sometimes kilometres long. In higher-frequency ranges the antenna is shorter – think of a mobile phone. An antenna tuned to a specific frequency provides the best signal receive and transmit strength. If you consider how signals are received on the Earth from satellites transmitting while orbiting in space, it might provide some appreciation for antenna design providing maximum signal strength.

Not all SDRs are the same. SDR components range from as little as \$15 to \$400 and more, depending on the specifications. Most can be purchased as a kit and come with wideband antennas. Wideband antennas are designed to work across a larger frequency range and tend to produce an average signal output



Quick tip

Carl Laufer's *The Hobbyist Guide to the RTL-SDR* is comparable to the ARRL *Handbook for Radio Communications*.

Origins of SDR

SDR originates from a discovery made about an inexpensive mass-produced DVB-T TV tuner dongle by Antti Palosaari, Eric Fry and Osmocom (in particular Steve Markgraf). DVB-T is an abbreviation for Digital Video Broadcasting-Terrestrial, one standard for digital television broadcasting first published in 1997. The standard defines frequency in the VHF and UHF RF frequency bands and how data is carried on the RF signal.

The pioneers of SDR discovered something unique about the Realtek RT2823U coded orthogonal frequency division multiplexing chipset. The raw I/Q data on the RTL2832U chipset could be accessed directly, making the DVB-T tuner a wideband software-defined radio. The custom driver software developed by Steve Markgraf was the keystone to SDR development.

Osmocom is an open source mobile communication project that develops software and tools for mobile communications. It is the maintainers of the RTL-SDR driver code today.

across the range. Recall antennas are tuned to receive or transmit on a desired frequency. If a weak signal is what you are after, wideband antennas are not ideal.

Devices will have specifications on the different features the device supports. Inexpensive SDR dongles lack some of the technology that increases

performance and provides stability. An example of this is temperature stabilisation circuitry.

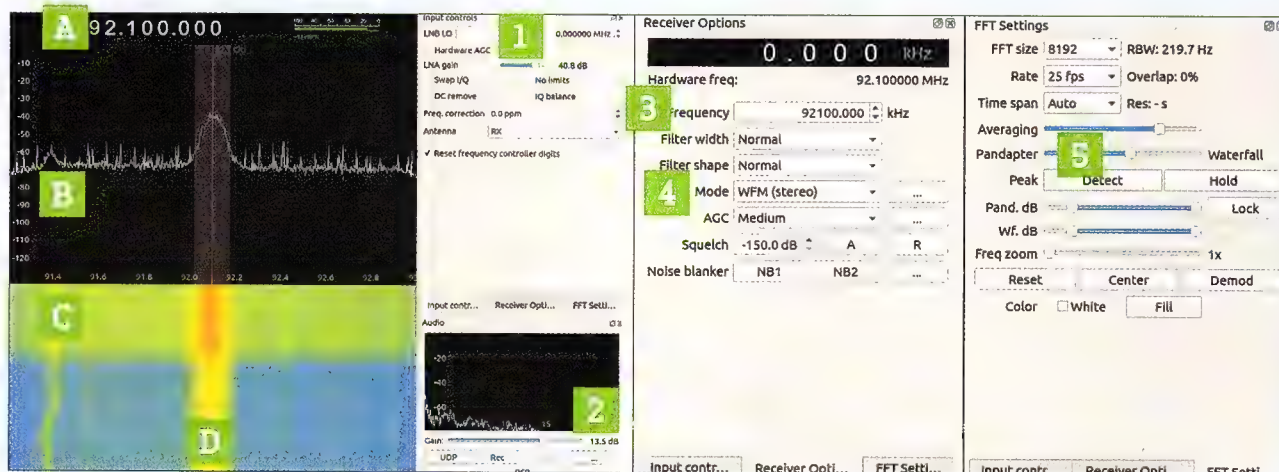
In the image on the first page in this article, the left SDR dongle is housed in a metal case, and the right dongle is plastic. The metal acts as a heat sink for the electronic components. Considering the ADC work the unit is performing

there's a chance the device will generate heat.

Using a \$10 SDR to receive the 'must have' critical weather broadcast is not a good design idea. Understand what frequency range you want to operate in and the variables that impact the range, and then make a purchase to reflect those specifications. Like receiving TV signal in

A tale of two apps

Gqrx



Under the receiver control tab there is a gain control (1) to adjust the amplification of the signal received. (2) is the audio gain control for the application. The small black screen is the audio signal frequency displayed in real time. This audio gain in the application is in addition to what your PC provides. Note: if your PC's gain is set to maximum and the app's gain control is at the minimum you won't hear any audio. Under receiver options tab, (3) is the local broadcast frequency. (4) Mode is the type of modulation, in our example FM. Under the FFT settings tab, (5) divides the far-left screen between signal screen (black portion) and the waterfall screen (blue/yellow mix).

On the main menu bar is a button to get the application running. You may be required to establish what device the

application is going to use.

Ensure Realtek RTL2838UHIR is the selected device.

(A) displays the broadcast frequency. (B) is the captured signal. (C) is the waterfall screen that shows the signal over time—waterfall means the signal falls off the bottom of the screen. (D) is the received signal displayed in yellow. Notice other yellow tracings for other signals.

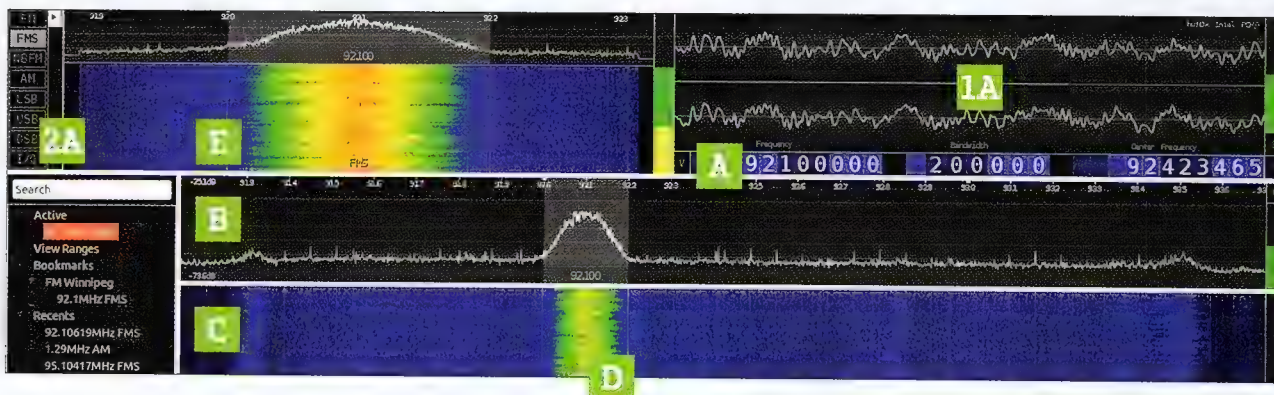
The gain control (1) impacts the status of both (B) and (C/D). If you increase the gain of a receiver, you are amplifying what is received. This includes the signal you want, (B/D) but it also includes all the other signals, which is why the screen has more yellow than blue on it. Increase the gain and you are amplifying noise along with the signal.

Now set up the second application.

Turn off Gqrx before starting. Select Menu > Other > CubicSDR. You will need to define what device the app is going to use. With that selected, pressing the start button kicks off the application. (1a) is the audio signal. Right click the screen portion and drag it either left or right to adjust. (2a) is the modulation used to encode the data.

Three frequency fields (A) exist. The far-right digits are the frequency drawn in the centre. The centre value is the frequency you wish to monitor. (B) is the display of the captured signal. (C) is the waterfall display. The received signal (D) is green. Weaker signals or noise are a light blue. (E) is an expanded view of the larger waterfall display to permit finer tuning.

CubicSDR



Tale of two dongles

Two SDR dongles were used in the project. One was a plastic-cased dongle with a fixed-length antenna, purchased from www.banggood.com. The other was a metal-case device with two adjustable antennas purchased at www.rtl-sdr.com.

Both units were used successfully. The former was CA\$15, while the latter was \$40. Both units can plug directly into a Pi USB port. The physical size of the SDR-RTL unit restricted access to the remaining USB ports. The banggood unit restricted access to the USB port directly below, but not the others. In order to plug into the unused ports the USB connector must be very thin or it won't get by the dongle. The performance of the RTL_SDR unit exceeded the banggood unit. The signal strength unit was higher and had greater stability in not drifting from the assigned frequency. The banggood unit signal strength was weaker, making it appear like it wasn't working. After confirming the setup with the RTL-SDR unit, the dongles were swapped and the banggood unit worked. The details are not a recommendation of a products. The information is provided to assist you in understanding that there are pluses and minuses when purchasing SDR dongles.

the 1960s, no one likes standing up holding the receiving antenna high above their head to receive a clearer picture. The cheaper SDR kit we used proved a challenge to get it to process a signal. If getting a cheap SDR to work is a user's first experience, we can see why future exploration would be rather discouraged, so bear this in mind.

A quick note on the connectors for antennas and the SDR dongles themselves. They are not all the same. Make note of the connector requirements if you are sourcing antennas separately from the dongle. It is frustrating to discover that the connector on the antenna doesn't mate with the dongle. There are adaptors available to enable the connection. This adds complexity and also impacts signal levels, so avoid them where possible.

A computer capable of running SDR software is the final piece. The SDR shifts the signal processing from electronic circuits to digital manipulation. For this project we are using a Raspberry Pi to run the software. Without a heat sink on the Pi chips or a fan circulating air around, you may receive warning signals of excessive CPU temperatures. Digital signal processing can require extensive CPU investment, generating heat.

SDR software is supported on a variety of operating systems. Linux was primarily used to develop this tutorial. A short foray into Microsoft Windows 10 was also needed to eliminate the suggestion that the problems in the cheaper SDR dongle were related to the OS software.

In this tutorial we are going to examine two software applications that are supported by the Pi. The first, **gqrx** (<http://gqrx.dk>), is software powered by GNU Radio and the Qt graphical toolkit. The software receiver enables you to demodulate received RF signals. The second, **CubicSDR** (<https://cubicsdr.com>), is an SDR application that can be used to navigate the RF spectrum and

demodulate any signals. It supports several common analogue demodulation schemes, such as AM and FM, and is continually being developed to support more digital modes into the future.

ENOUGH WITH THE THEORY

Our assumption is that the reader has sufficient knowledge to prepare a Raspberry Pi with the Raspbian operating system supporting the GUI. Before starting the exercises in this tutorial let's refresh the Raspbian OS to ensure that all the repositories and software loads are current. Log in to the Pi and open a terminal command line interface (CLI) window, and then enter the following command:

```
sudo apt-get update -y
```

```
apt-get upgrade -y
```

Keeping our eye on the prize of using SDR, bang out the commands to support RTL-SDR on the Pi and install the two software applications. Finish up with a reboot to ensure the Pi comes back ready to receive. Ensure your SDR dongle is installed before the reboot:

```
sudo apt-get install rtl-sdr
gqrx-sdr cubicsdr
sudo reboot
```

From the command line do a test to confirm the Pi is software-driver ready and detecting the SDR:

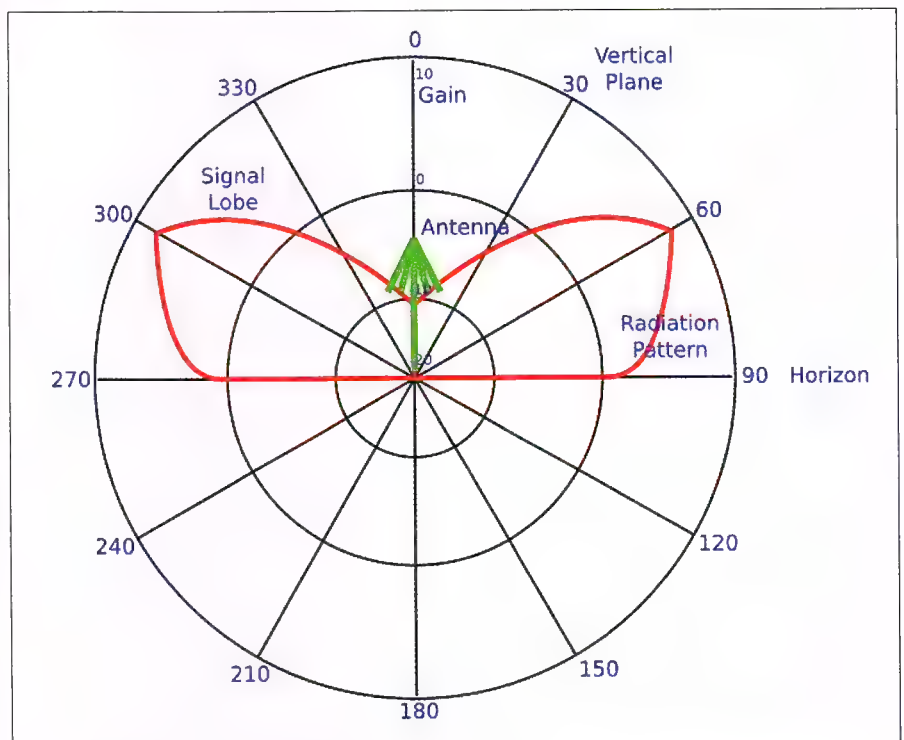
```
sudo rtl_test -t
```

The following is contained in the text output, depending on the SDR installed:

```
Found Rafael Micro R820T
tuner
or
Found Fiti power FC0012
tuner
```

The objective is to play audio from an FM broadcasted signal. In our rural area, we managed to get a reasonable signal level in a basement lab with the FM radio station on frequency 92.1MHz. You will need to use an FM radio station frequency in your area.

Using the Raspberry Pi GUI Menu > Internet > Gqrx, start the application. Set up a consistent screen display by opening the view menu and selecting input controls, receiver options, audio, FFT settings. This enables tabs on the right side of the display, middle of the screen. There are extensive resources for the gqrx application. Use the annotated pictorials to establish the settings for the FM broadcasted signal 92.1MHz. ■



Signal strength is in red, radiating out from the antenna in green.

Finding a new career in AI

From bushfires to coronavirus, the ever-growing thirst for answers has led to a continuing global shortage of AI skills. Darren Yates explains how you can skill up.

Back in 2016, IBM came out with the statement that 90% of the world's data was created in the last two years. If that's kept up, and there's no reason to suggest it hasn't, it's a simple insight into just how much data we all generate as we do daily life.

But increasingly, researchers are finding golden nuggets of knowledge hidden in that data, whether its cures for diseases or untapped profits for business. What appears to be in short supply, however, are experts with skills in data to find these nuggets. As machine-learning continues its march into new areas, demand for AI professionals is ramping up.

IS AUSTRALIA FALLING BEHIND?

Right now, there's a global AI arms race being run, but concerns are growing that Australia is falling behind. One reason is a lack of skilled AI professionals. Former Google Australia R&D boss and CEO of Cicada Innovations, Sally-Ann Williams, speaking at the recent 'Australian Financial Review Future Briefing' in February, reported that, based on her experience, local companies were likely over-estimating their AI expert head-count (tinyurl.com/tf2t2kd).

Data61, the CSIRO's data-science arm, produced a report in November 2019 that identified Australia as having 6,600 AI workers, up from 650 in 2014. However, that number will reportedly have to rise to at least 32,000 by 2030, with area expertise required in computer vision, robotics and human language technologies, among others.

Another problem Australia faces is the lack of collaboration between industry and research. According to the 2015 'Innovate and Prosper' report (atn.edu.au/siteassets/publications/atninnovateprosper.pdf), Australia ranked a miserable 29th out of 30 OECD countries for business-university collaboration. What's more, it appears to still be an issue today. At the same AFR Future Briefing, Australian Institute for Machine Learning director, Professor Anton van den Hengel, countered a common view that universities weren't interested in collaboration, suggesting local businesses needed to do more reaching-out to universities.

THE GROWING OPPORTUNITIES

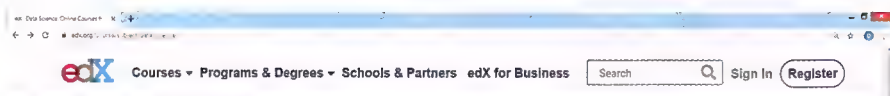
It's a little sad, for there are some seriously high-impact opportunities for AI at the moment. The recent bushfires that tore through large areas of south-eastern Australia left many devastated communities. This and other natural disasters are the focus of the Bushfire and Natural Hazards Co-operative Research Centre (bnhrcr.com.au).

It's part of a broad 'co-operative research centre' (CRC) program funded by the Australian government, under the Department of Industry, Science, Energy and Resources, bringing together governments, research institutions and industry on big-focus projects. Other CRCs include areas such as iMove (transportation), Food Agility (sustainable food) and Digital Health (tinyurl.com/wqp6mbk). However, the one factor many CRCs have in common is the desire to utilise data technology to boost innovation.

POSITIONS VACANT

At time of writing, employment website Seek listed 641 positions around Australia under the title of 'Data Scientist', which also encompassed roles such as 'machine learning engineer', 'data engineer' and 'applied statistician'. As an exercise, I analysed the first 100 jobs, looking for any mention of education requirements. These were categorised into four groups of increasing relevant degree-education level – none, Bachelors, Masters and PhD. Job listings mentioning more than one degree level were listed under the minimum required unless a preferred option was suggested, for example, 'Bachelor's degree (Masters preferred)' was classed as 'Masters'.

Of those 100 ads, 43 listed no formal education requirements – but before you celebrate too hard, each role required considerable experience in a range of coding, statistics and business intelligence skills. A further 31 roles



Data science courses on edX

Data science is a multifaceted field used to gain insights from complex data.

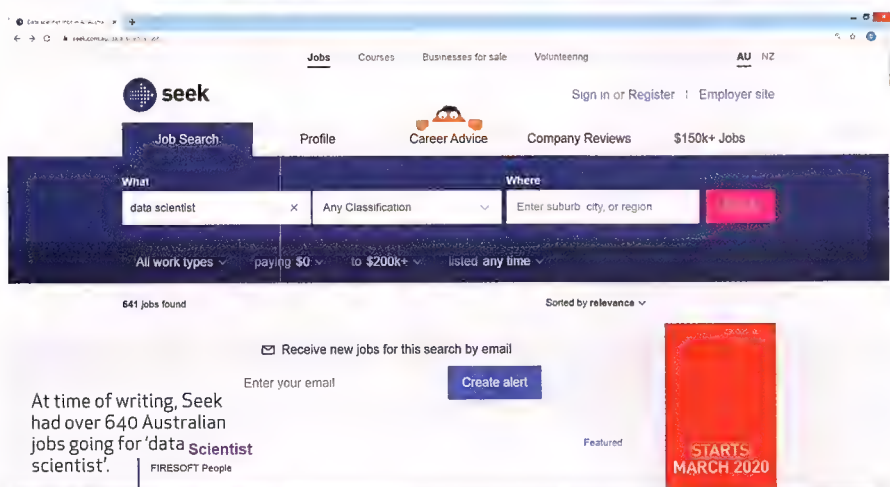
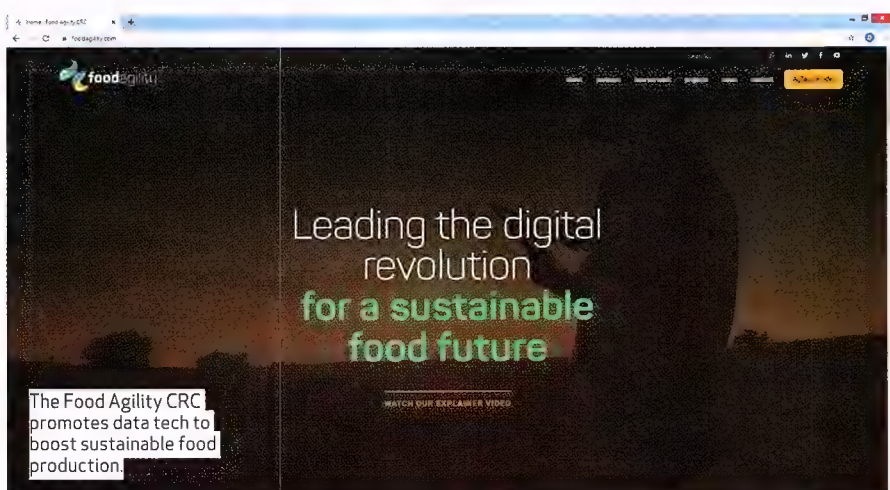
Data scientists use knowledge of

- Probability and Statistics
- Excel and Business Analytics
- Python

What is edX?

Real college courses from Harvard, MIT, and more of the world's leading universities.

edX is one of a number of online data-science course providers.



required a Bachelor's degree in a quantitative area, such as maths, computing etc, 13 positions required a relevant Master's degree and the remaining 13 required a relevant PhD. The job advertisers ranged from an international fast-food brand to local universities.

WHAT YOU NEED TO LEARN

As those job ads showed, AI is a pretty broad church, with different roles to suit different interests and strengths. However, virtually all of those roles are technical and good coding skills

are expected. Just about every 'top 10 programming languages' list over the last few years places Python and Java in the top-five (and top-three on many occasions). Of those two, Python is quickly becoming the 'go-to' language for machine learning, thanks to its easy-to-understand syntax and ever-growing library of add-ons.

A further analysis of the first 20 of those 'data scientist' jobs ads backed this up, with 17 (85%) specifically requiring Python skills, the most common language listed.

Following close behind and receiving

specific mention in 16 of those 20 ads was SQL. This might surprise but it shouldn't – much data exists in databases and clearly, having SQL skills is well-regarded by employers. The third-most common language mentioned was R, a statistical programming language well-known in data-science and machine-learning circles. All three languages were mentioned in 12 of the 20 ads.

However, coding is a foundation skill and even in junior positions, you'll typically need a good working knowledge of data science principles, such as 'deep learning' and predictive modelling methods, such as RandomForest.

The other key to remember is that machine-learning and data science are a means to an end, not usually an end in itself. Unless you're in specific research, the amount of time you spend dealing with actual machine-learning algorithms could be as little as 10% of the whole project. Other skills, from data collection and engineering to presentation skills, are also highly valued.

WHERE TO LEARN IT

With 43 out of 100 job ads not mentioning tertiary education requirements, there are plenty of roles where experience rates highly. However, that experience is very often based on having high-level foundation skills and knowing how to use them.

As for where to get those skills, there's no shortage of options – whether you're after something informal just to dip your toe in the waters, or you're ready for the rigours of more formal education. For starters, try Kaggle (www.kaggle.com), one of the largest data science communities online. There are lots of good textbooks as well – *Data Mining Concepts and Techniques* by Han, Kamber and Pei is a good overview.

If you're ready to get more serious, there are low-cost online courses from Coursera and edX (edx.org/course/subject/data-science). Many Australian universities now offer formal degree courses in data science, including the University of Adelaide, University of Technology, Sydney (UTS) and Western Sydney University, just for starters.

THE REWARD

Machine-learning and data science are the cutting edge of computer science – and will likely remain so for the foreseeable future. Learning it isn't an overnight task, but the breadth of areas it can be applied to is mind-boggling. If your current career no longer does it for you, the future is looking bright for AI, machine learning and data science. ■



Coronavirus wreaks havoc on the games industry

Conventions, supply chains and more are at risk.

The spread of COVID-19 has dominated headlines for much of 2020, and no less so in the games media. Evidence that the virus would adversely affect the industry started last month as major companies including Facebook, Microsoft, Sony and Activision all pulled out of major US conventions and trade shows including the Game Developers Conference and PAX East.

The former was cancelled at the last moment, while the latter soldiered on. As for E3 2020 in June, it's moving ahead "full speed" at the time of writing.

Meanwhile, industry analysts including the Asia-centric Niko Partners have predicted that COVID-19 could affect supply lines for both Sony and Microsoft's forthcoming next-gen

consoles. Other analysts aren't quite as certain, with Equity Research analyst Michael Pachter pointing out to Techradar that consoles rely less on Chinese manufacturing compared to, say, the smartphone industry. While neither the PS5 or Xbox Series X have a release date at this stage, both have been promised for a 'holiday 2020' release window.

After an impressive launch, publishers pull out of GeForce Now

BOTH ACTIVISION AND BETHESDA HAVE DELISTED THEIR GAME ON THE STREAMING SERVICE

GeForce Now isn't even out in Australia yet, but last month we reported that it could give Google Stadia a serious run for its money. But not all is well with Nvidia's streaming service, with major publishers Activision and Bethesda withdrawing their games from the service only weeks into its launch.

Activision's games were abruptly removed on February 16, due to confusion regarding whether the company's games would be included during the service's free trial period. It turns out, Nvidia thought it was fine;

Activision didn't. When Bethesda pulled out a week later no similar reason was given, though Nvidia did offer this general statement: "As we approach a paid service, some publishers may choose to remove games before the trial period ends. Ultimately, they maintain control over their content and decide whether the game you purchase includes streaming on GeForce Now. Meanwhile, others will bring games back as they continue to realise GeForce Now's value."





New Halo-inspired Nerf guns also give you in-game cosmetics in Halo Infinite

Live out your Master Chief fantasies.

Nerf is making a line of *Halo* toys in time for this fall's *Halo Infinite*. The current lineup consists of three different toy guns that shoot the company's classic foam bullets. The marquee toy in the new lineup is probably the MA40 Blaster, which is not just a new gun coming to *Halo Infinite*, but it's also the biggest of the trio coming from Nerf. On top of that, buyers will also receive a code to use in the game to unlock the toy's colour scheme for the same gun.

If you prefer something more compact, two more toys are coming via Nerf's Microshots line, which are often single-hand, smaller guns. In the case of the *Halo Infinite* toys, that includes the iconic Covenant firearm, the Needler, as well as a UNSC weapon called the SPNKR. Each of these Microshots toys will come with two darts and fires one at a time. The smaller two items will retail for US\$10 while the biggest of the trio will sell for US\$50. All three will begin to hit major retailers on October 1.

Overwatch and Diablo animated series are reportedly in the works at Netflix

NEW LEAKS SUGGESTS BLIZZARD AND NETFLIX ARE MAKING ANIMATED SHOWS TOGETHER.

Netflix is working on animated shows based on both the *Overwatch* and *Diablo* game franchises, according to President of Activision-Blizzard Nick van Dyke, who has listed the projects in his LinkedIn profile.

According to said profile, Van Dyke is an "Executive producer of *Diablo*, a TV adaptation of Blizzard Entertainment's IP, rendered in anime style [...] currently in pre-production for distribution worldwide through Netflix."

A little further down, the resume also refers to "an animated series based [on] Blizzard's *Overwatch* franchise." While Netflix isn't explicitly mentioned here, we can take an educated guess that the streaming service is involved, given that it's working on a similar adaptation for Blizzard's *Diablo* IP.

That said, neither Blizzard nor Netflix have confirmed anything officially, so there's still no guarantee that either of these projects will get off the ground. New shows get greenlit and cancelled all the time, but here's hoping that these two will eventually see the light of day.

Riot Games set to challenge Counter-Strike and Overwatch

VALORANT IS A 5V5 FREE-TO-PLAY SHOOTER THAT WANTS A SLICE OF THE ESPORTS MARKET.

Riot Games unveiled *Valorant* last month, a brand new free-to-play first-person shooter with a focus on high speed tactical play. The game, which looks like a blend of *Overwatch*'s character-based gameplay and *Counter-Strike*'s more sober, tactical approach, is expected to release this winter, with Riot paying special attention to netcode, fairness, and accessibility.

A new Test Drive Unlimited game is in development

THE STUDIO BEHIND THE WRC AND TT ISLE OF MAN SERIES IS RESPONSIBLE.

It's been 14 years since the original *Test Drive Unlimited* set the template for open world racers, and nearly ten since its lacklustre post-*Burnout Paradise* sequel. So it's about time the series was revisited, and now we have confirmation that it will be: KT Racing - Kylotonn, the studio responsible for the *World Rally Championship* series, is currently developing an instalment. According to Nacon head of publishing Benoit Clerc speaking to VentureBeat, "they're [Kylotonn] currently working on our biggest project by far, which is the next *Test Drive Unlimited* game."

The Call of Duty movie is delayed indefinitely, says the director

THE MOVIE IS NOT OSCAR MIKE.

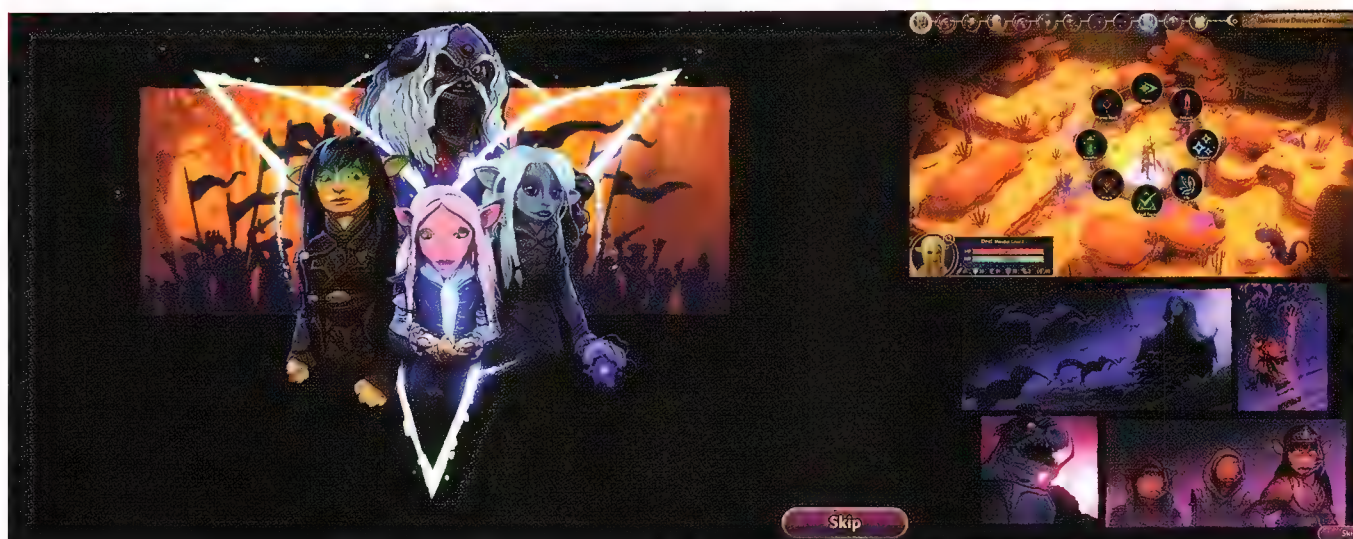
Speaking to Italian entertainment outlet Bad Taste, director Stefano Sollima said the project has "stood still" for two years.

"Well, the *Call of Duty* film has remained a bit like this ... We wrote the script with Scott Silver, which is who wrote *Joker*, and let's say that the idea of expanding the universe, the world of *Call of Duty* to film, it is no longer at the moment an industrial priority..."

Rainbow Six Siege coming to PS5 and Series X on launch day

THE TACTICAL SHOOTER WILL ALSO INTRODUCE CROSS-GENERATION PLAY.

Rainbow Six Siege is heading to PS5 and Xbox Series X, launching on the same day as the consoles. That's according to game director Leroy Athanassof, who was speaking to Windows Central. Athanassof said, "What I can tell you is that we are going to be on [the consoles] from launch. When they will release the consoles; but it's up to them to agree that. For *Siege*, our target is to be available right at launch." ■



\$29 | ENMASSE.COM | PC, MAC, PS4, XBI, SWITCH

The Dark Crystal: Age of Resistance Tactics

A very pleasant surprise.

I love strategy games. I love *The Dark Crystal*. But heading into this adaptation of the Netflix TV series, I was pretty sceptical of the idea of squishing the two together. It's a pleasure to report that while *Age of Resistance: Tactics* never fully justifies the combo, it's a far richer and more substantial game than you might expect.

For those unfamiliar, the show (itself spun out from a 1982 cult movie) takes place in a strange fantasy world, represented primarily through puppetry and animatronics, where the peaceful Gelflings are oppressed by the parasitic Skeksis. The game loosely retells this story, with a few new diversions, though in a way jumbled and fleeting enough that anyone who hasn't watched the series will be utterly lost. With too little explanation for the uninitiated, and not enough new elements to please fans

"It's a far richer and more substantial game than you might expect."

looking for significant additions to the canon, the storytelling falls flat. But where the game shines is in its action. As you progress across the campaign map, you put together parties of heroes – from a stuffed roster of characters from the show and new additions – to fight in turn-based battles. Thanks to clear presentation and a generous undo button, the strategy is pleasingly accessible, while still boasting plenty of depth to sustain its surprisingly chunky 20-hour runtime.

Stages get cleverer and more elaborate as you go, showing off a real flair for strategy design. On coastal islands you have to keep an eye on the tide, which may rise to drown hapless fighters, or lower to expose

new routes; in the dungeons of the Skeksis, your party is at one point divided along two routes, each having to find and hit levers that open doors for the other; and in the Grottan caves, a stage challenges you to line up boulders and whack them into burrows to stem a tide of beasts, like a giant game of Gelfling snooker.

While the strategy combat is good fun throughout, its relationship to the source material is variable to say the least. A fight against the Chamberlain evokes the show nicely, as he uses honeyed words to confuse your heroes. But representing Brea's search for knowledge as a skirmish against a squad of librarians is awkward at

best. Enjoyable as the battles can be, it was rare for an hour to go by without something in the game reminding me that this isn't the ideal genre for a *Dark Crystal* adaptation.

It's not going to reshape anyone's world, but for a cheap TV tie-in it's a lot more engaging than it has any right to be, serving as a pleasant opportunity for series fans to spend a few more hours in the company of their favourite Gelflings.

■ Robin Valentine

Verdict

This Netflix tie-in is an awkward adaptation, but it still makes for a surprisingly smart strategy game.





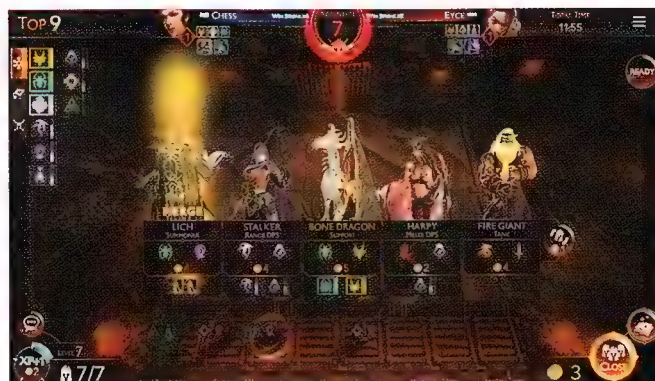
FREE | [PLAY.GOOGLE.COM](https://play.google.com) | PC, IOS, ANDROID

Might & Magic: Chess Royale

The auto-battler hits turbo speed.

For the most part, *Chess Royale* lives pretty straightforwardly up to its title. Leaning heavily on the *Might & Magic* franchise to provide a little extra validity, it places a relatively unambitious autobattler into the vaguest-possible battle royale framework, encouraging 100 players to fight it out for top spot. It's an amusing gimmick to add to a new genre, but it does little to change the way players interact with one another. When all your autobattler competitors are already last-man-standing affairs, bolting the word 'royale' to the end of your title isn't exactly revolutionary.

Nevertheless, adding more than 90 extra players to the usual formula does change things up a little. Rather than a traditional health bar, *Chess Royale* grants players three lives. The first round is something of a freebie, granting a risk-free opportunity to start building your army, but after that opening battle, every round you lose will cost one life. As players run out of lives, their avatars disappear, the 100-person grid that charts progress through each game gradually turning to black as



more and more armies are knocked out. It's a ruthlessly efficient means of thinning the herd – whether it's a close fight or an absolute rout, you'll lose the same amount of health – and it also ensures that you won't spend a frustrating half-hour rolling for the one unit that might turn your fortunes around.

The result is an autobattler that's much faster than its competitors in spite of its bloated player-count. PvE and 'Carousel' rounds are out, as is any sense of an economy – everyone receives the same reward at the end of a battle, with 'survivor' bonuses being granted across the board, and small 'slayer' prizes being awarded to those who eliminate other players from

the competition. Building your army is also a much quicker process here than elsewhere. Synergies – collections of units that share similar traits, such as mages or assassins – are far easier to establish than in *Teamfight Tactics*, as there are fewer to build around. Items are replaced by spells, which can impact the entire board, rather than just specific units.

■ Alistair Jones

Verdict

An effective introduction to a sometimes confusing genre.



Hive Time

Build a thriving bee community.

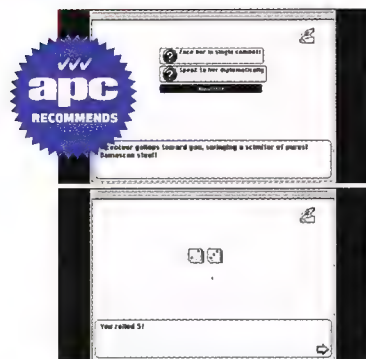
FREE | PC, LINUX, MAC | [CHEESENESSE.ITCH.IO/HIVE-TIME](https://cheeseness.itch.io/hive-time)

You're in control of a small hive that's only just about ticking over. There are few workers buzzing about in search of nectar, while the queen sits on her throne twiddling her antennae. To succeed, you'll need to gradually expand your borders, research new technology, and construct workshops and storerooms for all those lovely resources. Your ultimate aim is to make royal jelly, with which you can replace the serving queen when she eventually dies. But that's a long way off yet: a persistent, growing threat lurking in the periphery.

You'll spend most of your time in *Hive Time* futzing about with population sliders, trying to make enough drones to staff your various bee departments. The early game can feel painfully slow, but the later game is a stress-fest. There's no option to speed things up, or slow down time. This is not a game with a vast amount of character, but there is humour in the descriptive text, and in the random events that crop up every so often. ■

Tom Sykes





Madness of the Coastal Structure

Hypercard gaming returns.

FREE | PORPENTINE.ITCH.IO/COASTAL-STRUCTURE | PC, LINUX, MAC

Built using the Hypercard Framework, *Madness* is a text adventure that feels extremely early '90s. The realm of Madness isn't a cohesive one. Centaurs rub shoulders with enchanted pop bands, strange machines and other oddities. It's a game crammed full of memorable sights, and with playful writing that makes the most of every encounter. After arriving in a jungle, you soon find yourself exploring an imposing tower that's at once modern, futuristic and fantastical. You'll roll dice and improve stats and come to a sticky end, probably lots of times. Yep, this is one of those adventures that wants you dead.

This could be annoying, but it isn't in the least. *Madness* has the good grace to smile as it shivs you between the ribs. The deaths are probably the best bit, written with obvious glee – and you can always reload, or rewind, to return to life. Perhaps the atmosphere is a bit thin. You may love or hate the self-aware tone. But this is what it's like when a dev is having fun making a game. ■ Tom Sykes



Deathtrap Dungeon

Throws the book at you, and it hurts.

This is not, strictly speaking, a videogame adaptation of the book *Deathtrap Dungeon*. With a few tiny tweaks, it is the book *Deathtrap Dungeon*, albeit a version that allows you to pretend that you're friends with the actor Eddie Marsan, who takes care of the reading and dice rolls for you. Every word is read to you by Marsan while he sits in a supremely comfy-looking chair. Although the setup initially feels rather weird, Marsan's subdued yet nuanced delivery quickly places you squarely into a world of danger, death and avarice. He's a very good storyteller.

The dungeon of the title is like a cross between *Saw*

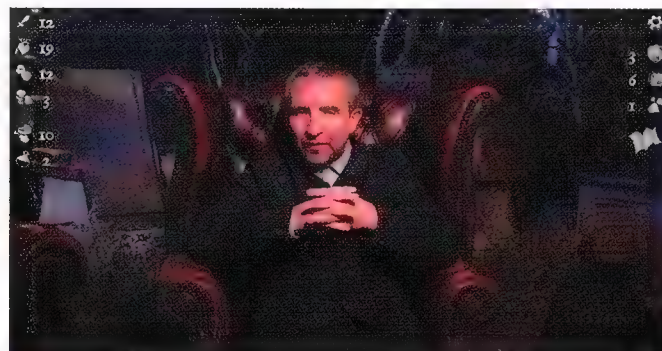
and *The Hunger Games*, but in a D&D-style world. You'll need to make your way through a constantly challenging gauntlet of puzzles, traps and combat with the promise of wealth at the end. Success or failure is down to skill checks, so how you set your character out at the start is crucial.

Battles are simple. Your Skill value is pitted against that of your opponent, plus the value of two dice. If the totals are the same, nobody takes damage; if one side has a higher skill plus dice number, the other loses two stamina points. The random nature of the dice rolls means that, unless you begin with

extremely high skill, surviving until the end is difficult, and even unlikely. Depending on the path you take and how your luck holds out for certain events, you can lose some or all of your stamina-replenishing provisions, and/or have your skill permanently reduced.

A perfect playthrough would take about two and a half hours. It takes me seven hours of trudging backwards and forwards before I finally exit the dungeon triumphant. While that doesn't sound too bad, at least half that time feels more like work than play, and I skip a lot of skippable footage. Plus I eventually cave and search for a walkthrough for the original book, because I just want the whole thing to be over.

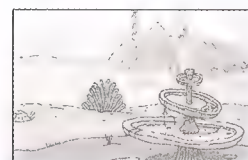
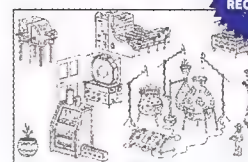
■ Luke Kemp



Verdict

Proof that a good book doesn't automatically make for a good game.





Haunted Garage

Tinker with instruments.

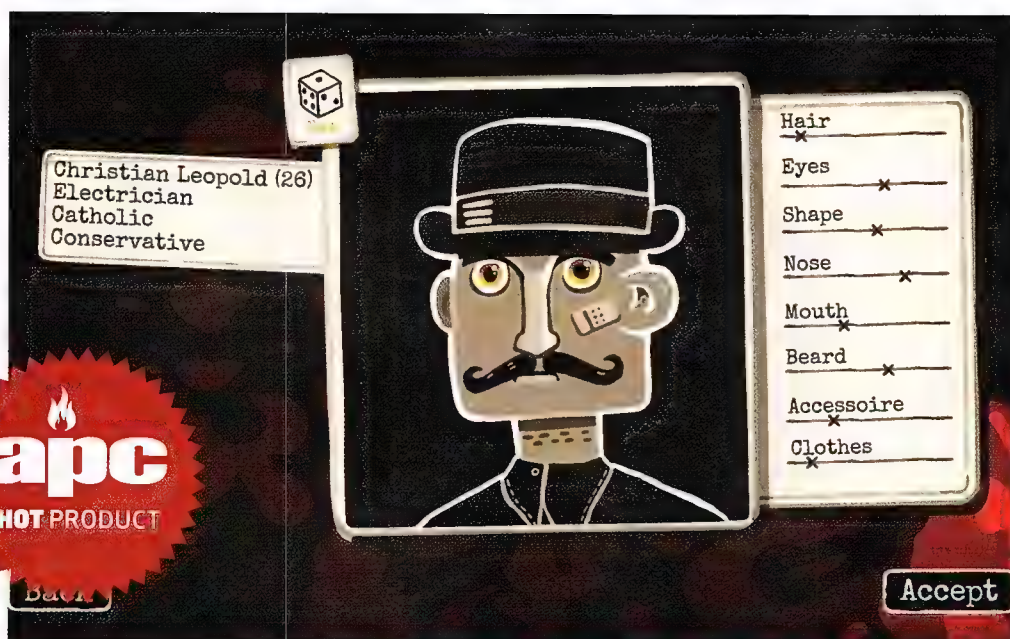
FREE | HAUNTEDGARAGE.ITCH.IO
HAUNTED-GARAGE | PC, LINUX, MAC

Haunted Garage gives you an endless white void in which you can stash a collection of fictional instruments. The absolute best part of this peculiar adventure game is playing with those devices, clicking on each to connect wires and flip switches and twist dials, to see what noises you can produce. They all play at the same tempo, and can be left alone once cajoled into life, creating an automated orchestra. You're a scientist, a tinkerer. A kid in a toy shop, pushing all the buttons to see what happens.

But that's only half the story. Click on a door inside the void and you'll be taken to the world outside, which is full of missing items, and people seeking them. So, you scroll around, you click on things (in the manner of a hidden object game), and you ferry the items back to them. In return you're given new instruments.

It's also an absorbing music game featuring some of the best virtual instruments money can't buy. You'll finish the adventure bits just to get to the music ones, to return to your rapidly expanding instrument collection.

■ Tom Sykes



\$25 | PAINTBUCKET.DE/EN/TTDOT | PC, MAC

Through the Darkest of Times

Get a taste of living through momentous events...

It's incredibly difficult to truly comprehend the enormity of the atrocities of Nazi Germany. But this pigeonhole-defying game, while still fully failing to communicate the scale of events, opens your eyes somewhat wider in a very impressive way. The result is an incredibly affecting emotional journey through history.

You and your small band of resistance members are German citizens. The story begins with Hitler becoming chancellor in 1933, and runs right through until the aftermath of the war in 1946. Each turn represents a week, and you need to decide which tasks to assign to each of your members.

Success in each task is determined, in part, by the total value of the relevant attributes offered by the characters you assign. Things aren't as simple as that though. Even if an action is successful, there's a high chance that at least one member will start to gain the attention of the authorities. If I leave this unchecked, the Gestapo will arrest them, taking them out of action. Any heat on any members assigned to a task starts to



increase the risk of failure. I need to select tasks to keep my ever-depleting supply of supporters up, too. If I lose too many supporters, or group morale hits zero, it's all over.

Nobody around me can be guaranteed to be immune to the toxic charms of the charismatic Hitler and his all-powerful party. Most of these supporters of fascism, rather than being cartoonish villains, are otherwise unremarkable and... nice. They bake cakes. Host parties. Talk to me politely. There are vocal and angry critics of the Nazi regime, but they risk not only arguments with their peers, but the potentially deadly wrath of the authorities.

One side of the game

explicitly tells the final chapter in Hitler's rise and fall, from the perspective of ordinary citizens trying to navigate the repulsive views of their friends and inconceivably horrific rumours regarding the regime. The other side forces you to juggle the urge for action with the need to care for your group, with no easy answers. It forms a cohesive, uncomfortable whole. ■

Luke Kemp

Verdict

A superbly crafted game that serves as storyteller, teacher, and concerned friend.



downtime » game changer



Jedi Knight's Stormtroopers
wail like a baby when they die.



Jedi Knight: Dark Forces II

It's tricky to get running, but LucasArts' blaster can still swing it with the best of them.

The best way to judge the quality of any Star Wars fiction is to ask, "What's left if you take out the lightsabers?" Remove those iconic laser swords from the original *Star Wars* and you're left with basically the same propulsive adventure, only Darth Vader and Obi Wan settle their score with a fistfight instead. Take them out of the *Phantom Menace* and you're left with two hours of dead-eyed chat about trade negotiations while Jar-Jar pricks about in the background like a nerf herder.

The same notion applies to Star Wars games. Take the lightsaber out of *Jedi: Fallen Order* and you're left with a mediocre *Uncharted* clone. Take it out of *Jedi Knight: Dark Forces II*, however, and you're still left with a fantastic first-person shooter.

Admittedly, it's an FPS which requires some adjustment played today, both in perception and getting the bloody thing running. More on that second point later, but for now let's say that *Dark Forces II* does not like modern PCs at all.

On that first point, there's no escaping it, today *Dark Forces II* has all the visual appeal of Jabba's fat-rolls. Being an early true-3D shooter, all that extra power required to render proper polygons mean massively scaling down the level-of-detail on models and environments. Unlike *Quake*, which could tailor its art to suit its visual limitations, *Jedi Knight* is a Star Wars game, and therefore needs to mimic the Star Wars aesthetic. Hence you end up with angular stormtroopers, lightsabers you can sometimes

see through, and a Kyle Katarn who looks like he's cameoing in *Minecraft*.

Still, there's a splendid shooter hiding behind that boxy exterior, one that reveals itself the moment you blast your first Gran (alien, not octogenarian) in a Nar Shaddaa dive, and he topples to the ground with bone-cracking force.

HIT REACTIONS

Jedi Knight may look terrible, but it still feels amazing. And the way enemies react to being hit is just a part of it. Movement has a wonderful inertial quality. You start moving forward slowly and gradually accelerate. When you stop, you glide slightly before coming to a halt. Normal movement is relatively slow, but if you sprint *Jedi Knight* suddenly turns into *Quake*, with



Your lightsaber can chop-off arms, although it's a rare occurrence.



The rail detonator is one of the more obscure weapons in Star Wars games



you able to zip around maps at blistering speed, and that's without the Force Speed upgrade you get later in the game.

Weapons are equally satisfying to wield. My favourite is probably the Stormtrooper blaster, which has a satisfying recoil and perfect pew-pew laser sound. But all the weapons have their merits. The Imperial Repeater is a ferocious rapid-fire weapon, useful for clearing crowds of enemies. The Rail Detonator is your equivalent of a rocket launcher, complete with a devious alt fire where its rockets stick into surfaces and enemies for several seconds before exploding. The Concussion Rifle is so ludicrously powerful that it's positively suicidal, wiping out everything when fired in a confined space, including yourself.

Jedi Knight also spins an entertaining Star Wars yarn, commencing as a chase for a nefarious droid known as 8t88, who has information on the death of Kyle's father, before slowly evolving into a race to the Valley of the Jedi, where Kyle must confront a group of Dark Jedi (as they are known-in game)

led by a powerful Sith named Jerec. Most of the story is told through FMV cut-scenes, which are surprisingly enjoyable despite the bad CG and looking terribly grainy on a modern screen. They're on the campy side, but I'd argue they feel more Star Wars in tone than any of the prequels, with a strong forward momentum and no tedious politics.

STORY TIME

As with all good shooters, however, *Jedi Knight* does its best storytelling through its level design, which provides a huge variety in environments and ideas. In Nar Shaddaa, you battle with Gamorrean Guards and Rodian gangsters along perilously high gangways and across cargo-bay conveyor belts, using the crate lifts to ascend higher and higher into the city-moon's endless skyline. Then you travel to Katarn's home planet, searching his father's dilapidated house while Tuskan Raiders ambush you in the darkness.

And those are just the

DUEL OF THE FATES

The Dark Jedi standing in Kyle Katarn's way.



YUN

The youngest and least experienced of Jerec's crew, Katarn cuts his teeth against Yun in one of the Dark Palace's antechambers.



GORC & PIC

Ensuring Jedi Knight reaches its muppet quota, the giant Gorg and diminutive Pic make for an intriguing battle.



BOC

The mad Twi'lek Boc battles with two lightsabers and leaps about like an angry frog, resulting in the most unique of *Jedi Knight*'s battles.

MAW

Half-man, all evil, the legless Maw uses a repulsorlift carriage to float around environments, battling Katarn on a spaceship landing platform in one of the game's most dramatic duels.

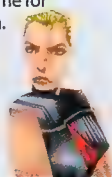


JEREC

Katarn's final Jedi confrontation with the eyeless Inquisitor Jerec is a straightforward Sith v Jedi showdown. It's truly epic stuff.

SARISS

The only female Sith in Jerec's coterie, Sariss battles Katarn after he confronts (and possibly succumbs to) the Dark Side, resulting in a very different outcome for Katarn.



This is about as detailed as the game's environments get.



starting levels. The real highlights of *Jedi Knight* come later. At Baron's Hed, you navigate through the city's sand-blasted streets, rescuing the civilians from 8t88's thugs, before crawling through a ruined district to reveal the vast Imperial Tower of Into the Dark Palace. Here, a literal army of Stormtroopers supported by AT-STs stand between you and access to the palace. In the game's second half, you'll navigate the subterranean pipelines of an interstellar fuel station, fight across the surface of a spaceship as it flies in-atmosphere, and in one of the game's most unique missions, try to escape another spaceship as it plummets to the ground.

What's most striking about *Jedi Knight*'s level design is how Star-Wars-y it is, far more so than *Fallen Order*'s generic range of planets. *Jedi Knight* communicates the weird sense of scale many Star Wars locations have – the lofty hangar bays, the ridiculously oversized ventilation shafts, the many perilous drops that reflect the film's locations such

as Bespin and the Death Star. *Jedi Knight*'s ledges and walkways are still capable of putting your heart in your mouth, as you need to leap across a chasm that seems to vanish into shadowy infinity below you.

All of this is great regardless of whether or not you're wielding a lightsaber. In that regard, *Jedi Knight* doesn't have the same level of nuance as its sequel. But *Jedi Knight*'s ethos toward lightsabers and force powers is much more in the spirit of the original films. Jedi are rare and powerful, but not invincible. You can try to play the game exclusively with the saber if you want. But until you've really mastered your force powers, a blaster is a much more efficient way of taking out a large group.

MOD FIXES

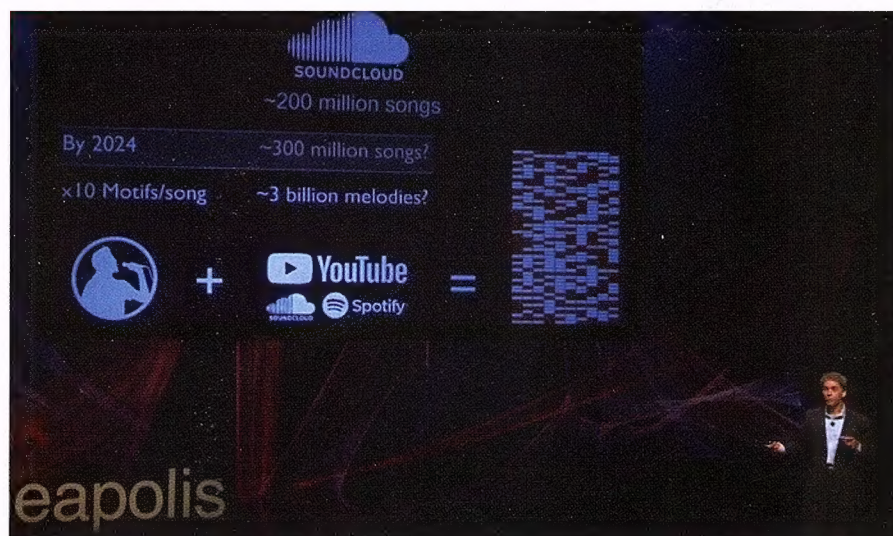
Unfortunately *Jedi Knight* has a highly unstable relationship with Windows 10, and in its default state will respond to switching on 3D acceleration by providing a black screen. Music and cutscenes also won't play in the vanilla version

There are several ways to fix

this, tutorials for which can be easily found online. There are also several different mods for improving the game's visuals, such as DarthTrank's 2009 FOV and Mipmap patches, which sharpen up distant textures and better adjust the game for 16:9 screen. There's also the *Jedi Knight Enhanced* mod, which replaces a lot of the character and weapon models with those from *Jedi Knight II*. Be warned though, some mods are incompatible with certain game fixes and vice-versa.

Even once you've got it running, you'll need to accept the risk of the game crashing whenever you open the options menu, alongside a slightly scratchy element to the sound that I found strangely enjoyable, like playing an old vinyl record on a gramophone. That is, ultimately, what returning to *Jedi Knight* is like.

LucasArts' most ambitious shooter is undeniably dated and is a bit of a faff to set-up. Once the record's spinning, however, its experience has a texture that's more than a match for modern tunes. ■ Rick Lane.



Programmers create AI to copyright every melodic composition possible

Tool designed to help artists avoid future copyright suits.

It's not uncommon to hear a riff or melody and feel as though (or know) you've heard it before somewhere, but if you look at the sum total of possible melodic progressions available it's no wonder there's some overlap. Copyright attorney Damien Riehl and programmer Noah Rubin teamed up to create an AI that makes 30,000 melodies a second and saves them as songs on a hard drive. These MIDI files are then made available on Github with a Creative Commons Zero licence in the hope of using it as a defence for future copyright suits.

Steve Wozniak Tweets that his wife may be coronavirus patient zero

APPLE FOUNDER CLAIMS HE ALSO STARTED THE CORONAVIRUS.

In what has to be one of the weirdest COVID-19 sideshows since #ToiletPaperGate, Apple co-founder Steve Wozniak, Tweeted that there's a good chance his wife was patient zero for the US coronavirus outbreak. In what was (we assume) an attempt at humor about his wife's sinus infection after returning from China on January 4th, Woz Tweeted: "Checking out Janet's bad cough. Started Jan. 4. We had just returned from China and may have both been patient zero in U.S." Her condition was later confirmed to be just a sinus infection unrelated to the new virus.



Steve Wozniak @stevewoz · Mar 3

Checking out Janet's bad cough. Started Jan. 4. We had just returned from China and may have both been patient zero in U.S. (@ West Coast Sports Institute in Santa Clara, CA)



West Coast Sports Institute
Get out. Explore. Download Swarm and live your life more checked in.
swarmapp.com

458

849

1.8K



Apple won't let bad guys use iPhones in movies

RYAN JOHNSON SAYS ROTTEN APPLES CAN'T USE THE WORLD'S MOST ELITE SMARTPHONE.

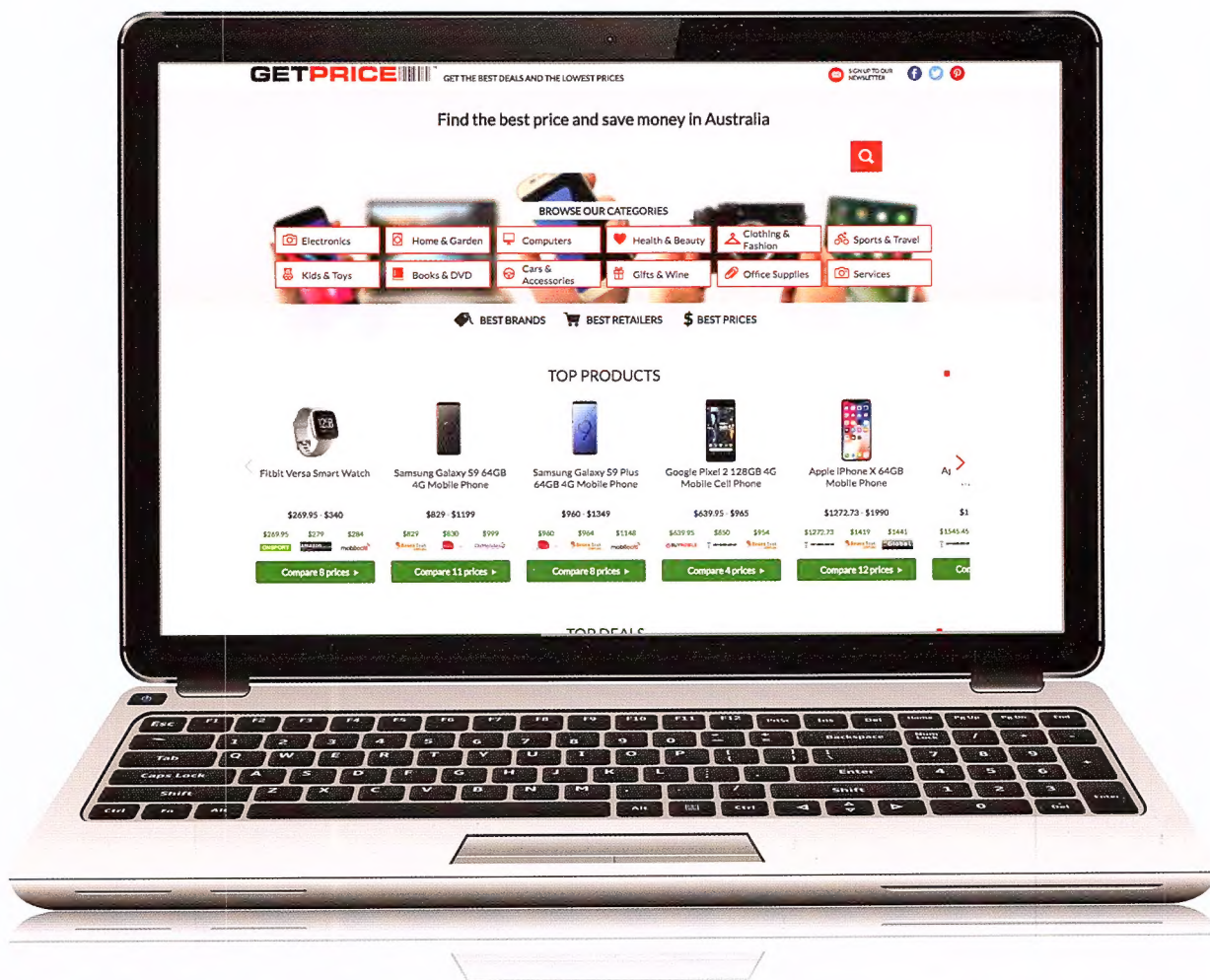
The director of recent box office hit *Knives Out* admitted he 'let the cat out of the bag' by explaining that Apple has a policy where it only sanctions the use of iPhones by a movie's good characters. *Knives Out* is a modern whodunnit, so anyone with a keen eye would be able to definitively tell if a character is bad or good by the type of smartphone they use. While the issue is pretty critical in a crime thriller like Johnson's latest work, you can't unlearn this cinematic fact. It just may be the biggest blanket movie spoiler ever told.



Ashton Kutcher brags he has his own Clearview AI app for personal use

'TERRIFYING' APP THAT'LL IDENTIFY PEOPLE USING A SMARTPHONE CAMERA.

Clearview AI has been making headlines recently for its software that uses scraped social media images and profile details to recognise faces from images or live video. While the company promises it's only available to some law enforcement agencies in the US, there are fears around misuse, especially if it became publicly available. In an interview on *Hot Ones* Ashton Kutcher said that he had a smartphone app on his phone that could find out exactly who you are if he held it up to your face. He didn't respond to questioning from *Mashable* as to whether this app was Clearview AI or something else, but if he was an investor he could at least in theory have access to it. ■



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